THE STARRY SKIES

Eclipse of the Sun. Frontispiece.

THE STARRY SKIES:

OR,

FIRST LESSONS ON THE SUN, MOON AND STARS.

BY

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10 EAST 23D STREET, NEW YORK.

Contents.

THE STARRY SKIES.

CHAPTER I.

THIS EARTH OF OURS.

ONCE upon a time—thus runs a certain tale—there was a man who wanted to see what could be found at the other end of the world.

So he left his home behind him, and started off to explore. He had a toilsome journey. He wandered over wide plains; he climbed steep mountains; he forded dangerous rivers; he crossed stormy seas. Through weeks and months, and even years, he kept straight on, steadily on, patiently on, never turning to right or to left. And at last, what do you think he found?

Was it a world of giants? Or a land of fairies? Or a dark ocean, without any further shore? Or a vast range of hills, reaching skyward? Or a profound depth, going downward?

He certainly must have found *something*, because he came to the end of his journey and travelled no more. He had no need to travel any more. His task was done: the puzzle was

found out; and he had arrived at "the other end of the world."

Only it was no "end" at all, but just the very same spot from which he had started. For he had actually found his way back to his own old home again.

Don't you think he must have been rather astonished? It was not at all what he had expected.

Suppose that a spider, living in the middle of a very big plain, were to make up his mind to walk to the outside edge of that plain, and see what might chance to be there. And suppose that, having climbed little hillocks, and crossed little brooks, trying always to keep steadily in the same forward direction, he were to find himself all at once back on the very same spot from which he had first set forth!

He would no doubt be a good deal surprised; and if he had sense to think the matter over he would see plainly that he had *not* managed, after all, to keep going straight forward, but that he must somehow have turned round without knowing it and gone back to his starting point.

The man in the story made no such mistake, however. He did not turn round. He went always on, and on, in exactly the same direction. Yet in the end he found himself at home! There is the curious part of the matter.

If the world were a flat plain, like the top of a large round table, the man could not have done this. It would be out of the question. He might have turned round and walked back; he could not have walked steadily onward and onward, farther and farther away from his home, only to find himself suddenly there again. The thing would be impossible.

Whether any living man ever took such a journey round the world is more than doubtful. But I can assure you of this: that if any man ever *did* take such a journey it would end just as that man's journey is said to have ended. By keeping straight forward, always in one direction, and by going on long enough, he would in time get back to his own house again.

How could he? That is the question. If a spider were to walk on for ever, straight across a flat plain, he would never get back to his starting-point.

But the world on which we live is not a flat plain. For a long while men believed that it was; and they made a mistake.

Let us think again of a spider—one of those tiny red spiders often found in a garden—and let us suppose this wee red spider to be standing on a huge round globe, as large as a house. Suppose that the spider, having very short sight, fancied himself to be on a flat table and resolved

to take a walk to the further end, to see what he might find there.

You and I, looking on, would know there was no *end* to the globe: but the spider could not guess this. He would walk on and on, in a straight line, believing himself always to be on a flat surface. And if he contrived to keep a perfectly straight line all round the globe—not an easy thing to do—then, whichever direction he began to go in, the end would be the same: if he kept on long enough he would go round the whole huge ball, and would arrive again at the spot where first he had stood.

If he did *not* manage to keep quite a direct line, but zigzagged a little to right or left, he would not reach the same *spot;* though even then he would get back to the same *side* of the globe as before. He would find no "end" to it, because a globe, properly speaking, has no "ends."

And this Earth, on which we live, is not flat, like a board or table, but round, like a globe or orange. It is really very like an orange; for an orange is not a perfect globe, but is a little flattened on its sides, or, as we commonly say, "at the ends." Our Earth also is rather flat in shape at the north and south poles. A round globe, like an orange, or like the Earth, has really no "ends" at all: though we often use the word when speaking of the two poles.

If you were to take such a journey, starting from your home, and keeping a perfectly straight line onwards always in one direction, you too would in time come back to the spot from which you started.

But a journey of this kind would be very hard to manage: far more so than it sounds. Every little hillock, every little streamlet, every house and every tree, to say nothing of rivers and towns, mountains and oceans, would turn you out of your path. By the time you got round the world, although you would return to the same *side* of the globe from which you first set out, you might be a long way off from the exact spot.

In case you do not know where the two "poles" are, you should ask some one to show you on a school globe. The north pole and the south pole are both very cold parts of our Earth. Ice and snow are there all the year round.

Half way between the north and the south poles is the equator—a line drawn exactly round the whole Earth: and all round the Earth, on or near the equator, are the very hottest countries. About half way between the north pole and the equator, and between the south pole and the equator, are the "temperate" parts of the Earth—not so very cold, or so very hot.

If a man is travelling from near the north

pole towards the equator, or from near the south pole towards the equator, he gets into warmer and warmer places.

But if he is travelling from the equator towards the north pole, or from the equator towards the south pole, he gets into colder and colder places.

The right name for a globe-shaped body, like an orange or like the Earth, is a "sphere." Neither an orange nor the Earth is a *perfect* sphere, because both have flattened ends; still, the ends are only a little flattened, and we always speak of the Earth as a "sphere."

A "hemisphere" means a "half-sphere." If our whole Earth were cut into two equal-sized pieces each of those pieces would be a "hemisphere."

We always think of the equator as dividing our Earth into two halves. The half towards the north is called "the northern hemisphere;" and the half towards the south is called "the southern hemisphere."

Since our Earth is said to be a round globe, like a ball, why do we not see over the edge? A fly, standing on an orange, would have, it is true, a rounded surface just under his feet; but he could take a good view downward over the edge. It would *look* like an edge to him, though there is no edge really to a ball.

If our world were as small as an orange, and we by comparison were each as large as a fly, then we should be able to do the same.

But the Earth is huge in size: and we are very tiny—yes, exceedingly tiny, side by side with the great Earth! And the surface on which we stand curves away so very gently, so very gradually, that it looks like a flat surface to us — just as the large globe would have seemed flat to the wee red spider, only very much more so. For the difference in size between the Earth and a man is far greater than the difference between the globe and the spider.

You may get some idea of how things are, by standing on the sea-shore, and gazing out to sea. Far away the sky and earth seem to meet in a long line, which we call "the horizon." That line is always around you, on all sides, wherever you are, though often you cannot see it, because of hills or buildings or trees coming between.

Beyond that line the rounded surface of the Earth *drops* away, so that you can see it no more. It is, in fact, what looked like an *edge*, to the fly standing on the orange. To us it looks much more as if the ground slanted upwards to meet the sky. But there is no real upward slant. After a certain number of miles, the surface of the ground or the ocean dips downward, out of

sight, and all else beyond that line is out of sight also.

Put your eyes close down upon a large schoolroom globe. You will see at once how the solid ball hides from you part of the room. You can see the ceiling, and perhaps the window and the fireplace, but beyond the globe all is hidden. Your *horizon*, as you stand thus, is just where you seem to see a sort of edge to the globe, beyond which its rounded surface dips away, out of view.

Looking upward into the sky we are able to see enormous distances — hundreds of miles, thousands of miles, millions of miles, billions of miles away! Light travels to earth from far, far distant stars: and we can perceive those feeble gleams because nothing comes between to hide them.

On the Earth it is very different. Here we can commonly see only a few miles off. Not because our eyes are not strong enough: but because the Earth's rounded surface soon dips away, and all beyond that dip is cut off from us by the solid body of the Earth.

On a flat plain, or close to the surface of the sea, our view is very narrow. If we climb a hill we get a wider landscape, because we can see farther over the "dip," and from a mountain-top the view is very greatly increased.

Sunset.

Still, no matter how high we go, the Earth's surface always stretches away to north and south, to east and west. It always *seems* to rise and meet the sky, making our horizon-line.

If we could get very, very far off indeed, into the sky, we should then see our Earth floating, like an enormous ball — a huge round solid globe. But this we are never able to do. We know our Earth to be a round ball: but we cannot stand apart and see her to be such.

Did you ever notice a ship "hull-down" on the horizon?—that is, with its masts standing up above the horizon, and its body hidden?

This again was caused by the shape of the earth: the hull of the ship having dipped down below the horizon, while the masts still stood up within sight.

When we see the Sun in the sky, he is always a round body. But when he sinks at night below the horizon part of the round surface is hidden first, and then the whole. Hidden in the same way: by the Earth's rounded surface coming between him and our eyes.

At the moment when the Sun is all but gone, only one glimmer being visible, you might say of him too, as of the ship, that he is "hull-down."

QUESTIONS.

1. What is a Sphere?

A body in the shape of a rounded ball or globe.

2. What shape is our Earth?

The Earth is a sphere in shape: but not a perfect sphere, because flattened at the north and south poles.

3. What is a hemisphere?

A hemisphere is a half-sphere.

4. Describe the two hemispheres of the Earth, commonly so called?

The northern hemisphere is the whole of the Earth north of the equator; and the southern hemisphere is the whole of the Earth south of the equator.

5. What is the Equator?

A line supposed to be drawn round the whole earth, exactly half-way between the north and south poles.

6. What is the horizon?

The horizon is that line in the distance where the sky and earth seem to meet.

7. What hides all below the horizon?

The solid body of our Earth.

8. How far can a man see on the Earth?

A few miles, usually. On a hill he has a much wider view.

9. How far can a man see in the sky?

He can see stars millions and billions of miles away.

10. What is meant by a ship "hull-down?"

A ship "hull-down" is partly above and partly below the horizon.

11. What becomes of the Sun when he sets?

He goes down below the horizon.

12. Is the Sun then too far off for us to see him?

No: he is only hidden from us after sunset by the solid body of the Earth coming between him and our eyes.

13. Does the Earth's surface really rise to meet the sky?

No: it really drops away, so that beyond a certain line we can no longer see it.

CHAPTER II.

WHY MEN DO NOT FALL OFF.

We come now to a curious thought.

The world is a round ball; and people live on all parts of it. Therefore, a man on the opposite side from us stands with his feet turned upwards towards our feet and his head pointing in the other direction—"hanging downwards, in short," you might say.

This seems extremely odd.

Suppose you hold a big ball, and place a pea on the top of it. The pea will stay where you put it, if you keep your hand steady. But if you place the pea at the side or bottom of the ball it will instantly drop away. Try for yourself, and you will see.

To be sure, a fly or a spider might stand with equal ease on the top or the bottom of the ball. The feet of a fly and a spider are made for clinging and walking in such a position. Man is not formed to stand or walk upside down, like a fly on the ceiling.

Now, why do n't the people on the other side of the world, in Australia for instance, drop off the earth, and fall away into the sky?

Of course there is a sky under our feet, just as much as over our heads. The entire world is surrounded on all sides by sky; not only over our heads, but down under our feet, beyond the solid Earth on which we stand, and in all directions.

If you were to travel round the world, and were to reach Australia—then, as you stood on the ground, your feet would point upwards to the feet of people in the United States; just as two flies, standing on two opposite sides of a ball, have their feet pointed, those of one fly towards those of the other. It cannot help being so, because of the shape of our Earth.

How do you think you would feel there? Do you think you would be in danger of dropping off the Earth into the blue sky?

Not in the least. No more danger of such an accident in Australia than in America. Nothing indeed would astonish you more! Instead of being disposed to fall from the Earth, you would find it every inch as hard there as here to get away from the Earth. Your own weight would hold you fast to the ground in Australia just the same as in America.

Try to jump up into the air, with all your strength. Try your very utmost; get as far away as you can from the ground, and stay up in the air as long as possible.

Not much good; is it? Do what you will, you do not find that you can rise more than a foot or two, and you instantly drop back again. The most powerful leaper can manage at most only a few feet. A man is quite unable to stay up in the air at all, unless something holds him there: far less is he able to drop or float away into the sky.

And the reason why he cannot is that he is too heavy. He is too heavy in America: and he is too heavy in Australia. In both cases he is heavy *towards the ground:* and he cannot get away from the ground without something to bear him up. It is just as impossible that people in Australia should drop off the world into the sky as that people in America should do so.

But—you will perhaps say—the sky is *above* us here; and in Australia it would be *under* us.

Oh, no; it would not! The sky is all round the whole Earth, on every side alike. In all parts of the world people have the sky over their heads and firm ground beneath their feet.

The Australian sky is under the feet of those who live in North America: that is true. But then it is no less true that the North American sky is under the feet of those who live in Australia. To you the Earth is underneath: the sky is overhead. To an Australian also the Earth is underneath and the sky is overhead. All round the world it is the same. *Down* means

always towards the ground. *Up* means always towards the sky.

If you hold up a stone in the air, and let it go, what happens? The stone drops at once to the ground.

If you fling a ball into the air, what happens? The ball goes a little upwards, carried by the force of your fling: but soon it curves over and comes to the ground.

If you tilt up a jug full of water, what happens? The water pours down upon the floor.

If a man steps over a precipice-edge, what happens? He falls to the bottom, and is most likely killed.

But these things are not more true of the United States than of Australia. All round the world, in every part, it is the same. Water always flows downward. Loose bodies always drop downward, unless kept up by something.

We have been asking why it is that people never drop off from the Earth into the sky. Of course nobody ever asks that question about the part of the Earth on which he happens to be. Whether he is in England, or in America, or in Australia, he knows very well that *he* is in no danger of "dropping off." The very idea as to himself would seem absurd. To "drop off" would really be to rise upward into the sky: and he feels that he is much too heavy for that. It

is only when he thinks about the other side of the world, and about people walking there with their heads hanging downward——

But they do *not* walk with their heads hanging downward. Their heads, like ours, point upward to the sky; and their feet, like ours, rest firmly on solid ground; and they too, like us, are heavy towards the Earth. It is as impossible for a man in Australia as for a man in England or America to "drop off" the Earth—in other words, to rise upwards towards the sky. His own weight holds him down.

What do we mean by "weight?" What makes a man "heavy?"

He is made heavy by the Earth's pulling or attracting him; and this gives him weight.

And how does the Earth pull?

There I cannot tell you much. We know that the Earth does pull: but how she pulls is another question. We name that pulling "Attraction," and sometimes we call it by a longer word, "Gravitation." But not the very wisest man living can explain to us exactly what attraction *is*. He can only tell us what it *does*.

Did you ever see a magnet? It is generally shaped rather like a horse-shoe: and the two ends have an odd drawing power. A number of tiny iron shavings, held near enough, will jump up to meet the magnet as if they were alive.

This is because the magnet pulls them towards itself. Sometimes a toy-box of metal ducks or fishes is sold, with a magnet; and they will follow the magnet to and fro, in a basin of water.

Now our Earth seems to be a sort of huge magnet, with power to pull towards herself, not only iron or steel, but every single thing and creature upon her surface. Not only on one side of the Earth, but around the whole globe, on every part, there is the same steady downward drag, always *toward the centre of the Earth.*

The mountains are pulled earthward: so are houses and trees, rocks and soils, seas and rivers, animals and men. There is not a single thing on or near the surface of our Earth which is not thus drawn earthward.

If it were not for this attraction nothing would have any weight. When you leap upward and instantly drop back it is because the Earth drags you down. Without such dragging you would not be heavy at all.

Think what that would mean. You might jump over the highest mountains with ease: or you might spring away into the sky, and never return: only, of course, there is no air, far away in the sky, and you could not breathe without air.

But if the Earth did not attract we should have no air here either, because it would long

ago have all wandered away. Earth's strong attraction holds the air prisoner, as well as all other things upon her surface.

Now do you begin to see how it is that people do not fall away into the sky, from any part of Earth? They are held firmly down by Earth's perpetual drag, which gives them weight. Whether they are in England or in Australia, in Asia or in America, makes no difference. The *pull* is always downward, always earthward. The difficulty always is to get away from earth, upward, toward the sky.

So when we think of the world as a whole we have to remember that in the surrounding sky there is no true "up" or "down" in one direction more than another. "Up" is towards the sky for each man, from that part of Earth on which he stands: and as our Earth is ever turning round and round our "up" is constantly changing its direction.

Perhaps you will think that I am rather slow in getting to my subject of "The Starry Skies." Two whole chapters first about this old Earth of ours!

But indeed I have not been slow: for on the very first page we started right off with a Bright World in the Sky.

By this time you know that our world is actually in the sky, just as much as the sun and

moon are in the sky. We are in the moon's sky, and in the sun's sky, and in the sky of all other planets and all other stars. For our Earth floats in the same boundless sky-depths as all of them, those sky-depths which are usually known by the name of *Space*.

So now, when "Space" is spoken of, you will understand. You will know that it means the Sky, in which float all the heavenly bodies.

"Only"—you will perhaps say—"the Moon and the Sun are bright; and so are the Stars. But our dull old world is not bright at all."

That is a great mistake, I assure you. Our world is very bright indeed. She shines with an exquisite radiance. Not indeed with such a dazzling glory as the Sun, but quite as brightly as the Moon.

Have you ever noticed how the ocean shines, and flashes forth light, when the Sun beats down full upon it? Or, again, have you not been struck with the shining of white clouds in sunlight? More or less the whole surface of our Earth catches and gives forth again the brightness that comes to her from the Sun.

If we could travel away from the Earth to a good distance—say, as far as to the Moon—we should see the round Earth like an enormous, brilliant Moon in the sky, only far larger and more beautiful than our Moon ever looks to us.

Some parts would be darker, some more shining; but as a whole the Earth would be a splendid sight.

Not bright? Yes, indeed; we are living on a very bright world indeed, though we cannot always see her radiance.

QUESTIONS.

1. What is Space?

By Space we mean Sky — the whole great Sky, in which are all the heavenly bodies.

2. Is our Earth in the Sky?

Just as truly as the Sun and Moon are in the Sky. They are in our sky, we are in their sky.

3. Does our Earth float in Air?

No; she floats in the Sky: and the air is a part of the Earth.

4. Do people on the other side of the globe walk head downwards?

No; they walk as we do, on firm ground, with the Sky over their heads.

5. What is meant by "up" and "down" to us on Earth?

On every part of the Earth *up* is always toward the Sky, and *down* is always toward the Earth.

6. Give some examples of the way in which all things move earthward.

Water always pours downward. A stone

flung, or a ball dropped, always reaches the ground.

7. Why do things descend thus?

Because of their own weight or heaviness.

8. What causes weight?

The pull of the earth.

9. Give two other names for that "pull."

Attraction and Gravitation.

10. Tell me a few things that are pulled earthward.

Men, animals, trees, houses, rocks, cities, hills, mountains, lakes, rivers, oceans, air, clouds, etc.

11. What keeps people on the other side of the Earth from dropping off into the sky?

They cannot possibly drop off; because the sky there is upward, the same as here.

12. What would "dropping off" really be?

It would be rising upward into the sky.

13. Why should a man not rise upward?

He cannot, because he is too heavy.

14. He is heavy towards what?

He is heavy towards the Earth, because of the Earth's attraction.

15. Is he as heavy in Australia as in the United States?

Exactly the same.

16. In what direction is he pulled there?

Towards the Earth. All round our whole world the pull is towards the centre of the Earth.

17. Can our Earth be called "a bright world?"

Quite as much so as other planets. If we were far enough off she would be seen by us to shine with reflected sunlight, like the Moon.

CHAPTER III.

BY DAY AND BY NIGHT.

LET us take a good look up into the sky, and see what is to be found there.

First, by day. Beginning in the early morning, just before sunrise, we have perhaps a clear sky, grayish rather than blue, and towards the east a brightening glow shows that the Sun is about to appear. That glow grows stronger and stronger, and soon a tiny glimmer creeps up over the rounded surface of our earth. Then the broad golden face follows, till the sun is visible, and full daylight has arrived.

But the Sun does not stand still there, low down on the horizon. He goes on rising higher and higher, "climbing the heavens" steadily, one hour after another. At mid-day—twelve o'clock—he has reached his very highest point. Then he begins to descend, moving downward towards the west till he reaches the western horizon and vanishes from our sight.

The Sun always rises in the East; never in the West. He always sets in the West; never in the East.

By this I mean that he always rises to *the*

east of our world and sets to *the west of our world.* He rises on the eastern side of the Earth and sets on the western side. You must not suppose that he always rises due east and sets due west of all countries in the world at once.

On two days only he does so—that is at the Spring Equinox, on March 21st, and at the Autumn Equinox, on Sept. 21st. "Equinox" means "Equal Nights." At those two dates days and nights are of the same length, twelve hours each, throughout the whole world; and everywhere the Sun rises exactly in the east, and sets exactly in the west.

Everywhere except at the north and south poles. There the Sun is seen to circle round the sky in twenty-four hours, just above the horizon, neither rising nor setting.

A man standing on the equator at one of the equinoxes sees the Sun rise just in the east; climb high in the sky just over his head; and set just in the west.

People living in the northern parts of Europe and of America do not see precisely the same thing. With them the Sun does not circle round the sky, just over the horizon, as at the poles. And though he rises in the east and sets in the west, as at the equator, he does not reach the highest point in the sky, but only a point somewhat lower down, towards the south.

The very highest point in the sky, exactly over one's head, is called "the zenith." In northern countries the Sun never gets to the zenith. No; not even on the very hottest summer day. He is always towards the south.

There are two other dates, which you ought to learn, besides the *Spring Equinox* and the *Autumn Equinox*. These are--the *Summer Solstice*, on June 21; and the *Winter Solstice*, on December 21.

On the 21st of June the Sun is not exactly overhead at the Equator, as at the Equinoxes. He has come farther north; not nearly so far north as England or Canada, but as far north as he ever does come.

By that time days and nights are not at all equal through the world. In the north of Europe and America we have long days and short nights; while our friends in Australia have long nights and short days.

Although the Sun is never actually overhead with people in the northern parts of Europe and America, but is always somewhat to the south, even at his highest point, still he climbs very much higher in June than in March or September, and so he is much longer above the horizon.

Things are quite the other way on the 21st of December. Then the Sun is overhead, not farther north than the Equator, but farther south.

Then it is summer in the southern hemisphere and winter in the northern. Then we who live in England or in the northern parts of North America have long nights and short days, while our friends in Australia are having long days and short nights.

Then, too, in the north, the highest point at mid-day which the Sun can reach is low down in the south; and his rays come to us in a slanting manner, with far less power to warm than when they are poured down from nearly overhead. That is why we are so cold in the dark months of the year.

At the equinoxes the Sun rises to the east and sets to the west of almost the whole Earth.

In our northern summer the Sun rises to the north-east, travels round by the south, and sets in the north-west.

In our northern winter, the Sun rises to the south-east, climbs up a little way, and sets in the south-west.

These changes come about slowly. Every twenty-four hours there is a difference. Each day of spring the Sun rises and sets a little more to the north, and climbs higher in the sky. Each day of autumn he rises and sets a little more to the south, and climbs less high in the sky.

But all the while, though he may rise to the north-east or south-east of New York or London

or some other particular spot, he rises to the east of the *world;* though he may set to the north-west or south-west of any particular spot, he sets to the west of the *world.*

You will find a grand description in the 19th Psalm of this daily journey of "the Sun, which is as a bridegroom coming out of his chamber, and rejoiceth as a strong man to run a race. His going forth is from the end of heaven, and his circuit unto the ends of it; and there is nothing hid from the heat thereof."

The full meaning of that heat and strength can hardly be known in northern lands. Their hottest summer day's heat is as nothing, compared with the scorching blaze and glare of the Sun in countries nearer to the equator—for instance, in that country where the Psalm was written.

Through all the ages of our world's history, from the very beginning, the radiant Sun has risen and set, day after day. Morning after morning he has come up from beyond the horizon on one side; evening after evening he has vanished below the horizon on the other side. Year after year, and century after century, still "like a strong man" he runs his daily race, and warms and lights each side of the world in turn.

Now about the Sky at night. What happens when the Sun is gone?

The bright blue of the sky grows fainter and more dull, and stars begin to show themselves.

First, one little twinkle is seen; then another little twinkle; then a third; till, if it be a clear evening, the whole sky is dotted with gleaming points. Some are more bright, some are less bright. Here one flashes like a diamond, with different colors; there another is so dim as hardly to be seen at all.

It may be that we have caught sight of the Moon before the Sun has set—should she happen to be in a right place in the sky, not too near to the Sun. While he is up, if we get a glimpse of her at all, she looks like a mere pale patch of whiteness. But when the Sun is gone, and darkness deepens, she changes fast; and soon she is lighted up with a soft silvery glow, sending her beams to the Earth.

Now, you all know—everybody knows—that the Sun rises each morning, crosses the sky, and sets each evening.

But perhaps not every boy and girl knows quite so clearly that the Moon and the Stars behave very much in the same manner. They too, either in the day or in the night, rise and cross the sky and set; and at night we may see them do it.

We cannot always watch the rising and setting of the Moon: for when she rises in the

day-time her soft beams are often lost in the glare of sunlight. Still she is always there, in the sky: always rising and setting to *some* part of our Earth. When we say, as we often do, "Is there a moon to-night?" we mean, "Is the moon where we can see her to-night?" There is always a Moon, and there is always the same Moon.

As to the Stars, their movements are puzzling, no doubt. No two stars rise at the same point or take just the same path over the sky, or set on the same spot. Some rise exactly east, and set exactly west. Some rise in the south-east and set in the south-west. Some rise in the north-east, and set in the north-west.

No star is ever seen, however, to rise anywhere towards the *west*, and to travel backwards towards the *east*. All the stars in company move as a whole *from the eastern side of the world towards the western side of the world*. That is to say, they seem to move thus.

Some stars to the north do not rise or set at all, as seen from the northern parts of Europe and North America. They only travel round and round, in a circle about the Pole-star, which is almost exactly over our north pole. Yet their movements too are from east to west.

If we lived in the southern hemisphere we should see the same thing going on nightly, only with a different set of stars.

Then the far-south stars would circle round and round over the south pole; and those lying over the north pole would be hidden by the Earth lying between. But still the whole movement would be always from east to west; never from west to east.

Each tiny star, bright or dim, takes its daily journey, like the sun, once in twenty-four hours. No matter whether it has to go right round the whole Earth or whether it only has to creep in a small circle round the Pole-star — still the journey is always the same in length: always close upon twenty-four hours. At the end of twenty-four hours it is back at its starting point, and begins over again. Just as the Sun does.

If you look out at night sometimes, and watch carefully, you will see for yourself something of this constant nightly journeying of the stars.

QUESTIONS.

1. Where does the Sun rise and set?

The Sun rises in the East and sets in the West.

2. Always in the East and West exactly?

Always to the east of our world and to the west of our world. Not due east and due west of each particular country always.

3. When is the Spring Equinox?

On the twenty-first of March.

4. When is the Autumn Equinox?

On the twenty-first of September.

5. What does the word Equinox mean?

Equal nights. At the Equinox, days and nights are of the same length over almost the whole world.

6. When is the Summer Solstice?

On the twenty-first of June.

7. When is the Winter Solstice?

On the twenty-first of December.

8. In what direction does the Sun rise and set at the Equinoxes?

At each of the equinoxes the sun rises due east, and sets due west, over all the world, except at the poles.

9. At the Summer Solstice where does the Sun rise and set?

To people in England, or in Canada, or in the northern States, he rises in the north-east and sets in the north-west.

10. And in the Winter Solstice?

To those same places he rises then in the south-east and sets in the south-west.

11. What do we call the highest point in the heavens, exactly over one's head?

The zenith.

12. Does the Sun ever reach the zenith in England, or in the northern parts of North America?

Never. He rises much higher in summer than in winter at midday, but he is always to the south of the highest point.

13. When or where may the Sun be seen precisely overhead?

On the equator, at the two equinoxes.

14. At what hour of the day may the Sun be seen exactly overhead?

Only at Mid-day.

15. Do any other heavenly bodies rise and set?

Yes; the Moon and the Stars; in fact, nearly all the heavenly bodies.

16. Can we see the Moon rise and set?

Sometimes; not always.

17. Tell me one reason why we sometimes do not see the Moon.

Sometimes she rises and sets at about the same time as the Sun; and then she is hidden by his brightness.

18. How do the Stars rise and set?

Like the Sun and Moon, they rise in the east of the world and set in the west of the world.

19. Do all the Stars take the same journey?

Some rise due east, some north-east, some south-east; and they set either due west, or north-west, or south-west.

20. Does every Star that we can see rise and set?

No; many stars to the far north never rise nor set to us in England or the northern States, but circle round and round the pole-star.

21. How long a time does this journey take—either round the world or round the pole-star?

Nearly twenty-four hours for each star.

CHAPTER IV.

HOW THE WORLD SPINS.

In our last chapter we saw how the Sun rises and sets in the day, and how the Moon and Stars rise and set in the night.

True, they also rise and set, by day as well as by night. The Moon often does so: and all day long there are Stars coming up in the east, and stars crossing the sky, and stars going down in the west. But we cannot see them. Until the great Sun has withdrawn his radiance the little star-gleams are hidden from us, and even the Moon can seldom be caught sight of.

In the daytime, when you look up into the blue sky, and see a blaze of sunlight, you should sometimes remember that the stars are there. All day long, as well as all night long, the stars are there, shining just as usual. All day long, as well as all night long, they are moving steadily across our sky: rising, marching onward, and setting. We cannot see them; but that is because our eyes are weak, not because the stars themselves do not shine.

So by day and by night the heavenly bodies seem to be ever on the move. No matter what

part of the world you may be in—whether England or America, whether India or Australia—still you will find them moving. By day you will see the Sun rising in the east, journeying towards the west, and setting. By night you will see the Moon, and most of the stars, rising in the east, journeying towards the west and setting.

This goes on continually. It is always the same. Year after year, there is no change.

The Sun rises in one spot, crosses the sky, sets; and then a few hours afterwards rises again in very nearly the same spot as before, to cross the sky by very nearly the same path, and to set in almost exactly the same part of the western horizon. Each day there is a tiny, very tiny, difference; but by the end of twelve months the Sun gets back to exactly the same spot in rising and setting as in the previous year. And most of the stars follow the Sun's example.

Why should not one fix upon a bright star overhead, and hurry along on the ground, just as fast as the star goes, so as to keep it overhead longer—to keep it in sight?

There is no reason why one should not do this, if only one could get along fast enough.

It would have to be very rapid travelling. If you wished to keep that star in sight, overhead, for twenty-four hours, you would have to do—

what do you think? You would have to rush *round the whole world* in twenty-four hours!

If you could possibly manage to do that, you might possibly choose any bright star overhead that you liked, and keep it in view all night; in fact for two nights, with no day between; for you would journey *with the night*.

Or if you chose to follow the Sun by day, keeping him overhead in your rapid rush over continents, and mountains, and oceans, you might have a double day of twenty-four hours, with sunshine all the while and no darkness.

But think what such a rush would mean! Think how big the world is! People sometimes do travel all round the whole earth, and the journey takes them many months. Even if they stopped to look at nothing by the way, and went as fast as possible, and cared nothing about being tired — even then, at the very least, it would take them many weeks.

To get round the world, on the Equator, or from England, or from the United States, or from Australia, in twenty-four hours, is a thing which no living man could ever do! The Sun and the stars go much too fast for us.

They are seen to whirl round the whole earth, swiftly and calmly and easily, with no manner of fuss or difficulty, once in every twenty-four hours!

Ah! but do they? That is the question. Do they really all whirl round and round, at this rate?

When you take a journey in a train, and look out of the window, what do you see?

Everything seems to be moving. The more distant hills travel slowly; fields and villages speed at a good rate; houses and hedges near at hand rush by; and the telegraph poles flash past as if running away. But one house does not go one way and another house in the opposite way. All of them journey in the same direction.

Do they really journey? Are the fields and hills, the villages and trees and telegraph poles, all spinning swiftly along, while you in your train sit quite still, not moving at all?

It must be one of the two things: either *they* are on the move, and you are quiet; or else they are quiet, and *you* are yourself rushing along, so that they only seem to move.

You would not have much difficulty in deciding. Even if you did not feel the carriage in which you sit to be shaking and jarring with its own rush, still you would count it easier to believe that the train was going forward than to think that all the hills and fields and trees and houses were speeding the opposite way.

It is almost the same thing with our earth. We see the Sun, and the Moon, and all the stars,

hurrying past, and we have to believe one of two things: either *they* are all moving, and we are still; or else *we* are moving and that makes them only seem to move.

For a long while people were not quite so sensible about the heavenly bodies in the sky as you would be about the houses and fields seen out of a train. It seemed to them easier to believe that all the stars went round and round the earth, than to believe that the solid earth herself moved.

There was this excuse, that the earth does not jar and rattle like a train, and also that the distances of the stars cannot be easily seen at a glance, like the distances of hills and valleys.

We have learned differently now. We know that our earth does indeed move; and that the daily journey of the Sun, the nightly journey of the moon and planets and stars, is not a real journey. It is only a *seeming journey.* They *seem* to move, because our earth truly moves, just as the hedges and trees *seem* to move when looked upon out of a train which really moves.

Day and night the earth moves. Day and night, year after year, she spins, like an enormous top, upon her axis.

By the "axis" of the earth I mean a straight line through her centre, from the north pole to the south pole.

If you have a school-globe you will see that it turns round and round upon a kind of large pin, which reaches from one pole to the other. That is its "axis," and that is how the Earth spins.

Or you may stick a long bonnet-pin through an orange, from one flattened end to the other, and spin the orange upon that pin, which is then the axis of the orange.

A spinning-top also has an axis. There is no pin stuck through the top; but as it whirls round, humming, and remaining in one spot, there *is* a line from top to bottom of it which does not seem to move. The whole top whirls round this line, which again is the axis of the top.

Our Earth has no huge pin passed through her body; but, like the top, as she spins there is a line straight through her, from the north to the south pole, which keeps still, while round it whirls the whole big body of the Earth. And that is the Earth's *axis*.

If a man stands close to the north pole, or close to the south pole, at either end of the axis, he moves very little. But if he is far away from the poles, on or near the equator, the ground on which he stands rushes along at a great rate, carrying him with it.

He does not feel the movement. He is not

shaken or jolted. The Earth whirls very smoothly. As she spins she carries with her, on her surface, all the mountains and seas, the hills and valleys, the trees and towns and villages, yes, and the very air which we breathe. Nothing is left behind.

So the man cannot know how fast he is going by any feeling of his own. He can only know it by looking up into the sky. There he sees the Sun, the Moon, the Planets, the Stars, all hurrying past. Why? Because *he* is hurrying past—not because they are.

They all go in the same direction, from east to west. We have seen this plainly. It is not a journeying of some stars one way, and some stars another way. It is one great sweep of the whole heavens from the east of the world toward the west of the world.

And the reason of this is that our Earth spins or whirls *from the west to the east.*

That is what makes the Sun and the Stars all seem to rise in the east and set in the west.

In the morning, when you get up early, and look towards the east, you are gazing at that part of the sky towards which you are travelling. The Sun is not coming to meet you, but you are going to meet him. This solid world on which you stand is whirling like a big teetotum, carrying you round in his direction.

So presently you see him seem to creep up over the horizon. And by-and-by, at mid-day, the moving surface of the Earth has carried you on almost underneath him. And later in the evening, as you are still whirled on toward the east, you leave the Sun behind you, in the west.

But still he goes on rising to other parts of the world, as country after country spins round into his light.

At night it is the same thing over again. Each star that rises only *seems* to rise, because we on the Earth's surface are whirled round towards that part of the sky in which the star always shines. Then we pass on, and leave that star behind, as we left the Sun; and we say that it has set.

But the Sun and the Star have not moved. It is *we* who have moved; not they.

So when we think of the Earth as a whole we have to picture her, not only as a large solid globe floating in the sky, but as a spinning globe, ever turning round and round like a top or a teetotum.

It is this whirling movement of the Earth which gives us *Day* and *Night*.

For, as our Earth floats and spins, one side of her is always turned toward the Sun, and is in daylight; the other side is turned away from the Sun, and is in darkness. Each land and ocean

in turn comes towards the Sun in the east and passes onward, leaving the Sun in the west.

And around, on all sides, is the great Sky, which sometimes we name "Space," and which sometimes we call "The Heavens." In that Sky float all the Worlds and all the Stars, as well as our Earth and our Moon and Sun. And in that sky is God himself.

He made the Sky, the Sun and the Moon and the Earth, the Planets and the Stars; and He is everywhere, around and amidst and in them all. Wherever in the boundless reaches of Space we may wander in thought, we shall never find a spot where God himself is not.

QUESTIONS.

1. Where are Stars in the day-time?

In the sky: only we cannot see them.

2. Could a man travel round the world from America or England as fast as a Star travels?

No: he would have to go round the whole world in twenty-four hours.

3. Do the Stars really journey round the world?

They only seem to do so.

4. But the Sun rises and sets, does he not?

He seems to do so. It is really our Earth that moves.

5. In what way does the Earth move?

Once in twenty-four hours she whirls round on her axis from west to east.

6. What is the Earth's axis?

An imaginary line through her centre, from the north pole to the south pole.

7. How does our Earth's spinning make the heavenly bodies seem to move?

A little in the same way that, when we journey in a fast train, houses and trees and fields seem to go the other way.

8. Did people always know that the Earth whirled round?

No; they used to think it was a real journeying of the Sun and Stars in our sky.

9. Where does the surface of the Earth move fastest?

On the equator. The ground there rushes at a great speed.

10. Where does it move most slowly?

At the poles.

11. Does a man standing on the equator feel how fast he moves?

No; because the Earth moves smoothly; and everything on the ground and in the air is carried along by the Earth.

12. How can he know that the Earth moves?

By looking up into the sky—like a man in a train looking out of the window.

13. How does the Earth's spinning make the Sun seem to rise?

The Sun remains fixed—but a man on the Earth is carried round towards the east, and so the Sun seems to come towards him from the east.

14. And how does it make the Sun seem to set?

The man is still carried on towards the east, and by-and-by he leaves the Sun behind him in the west.

CHAPTER V.

THE MOON BY NIGHT.

How far off would you guess the Moon to be from our Earth?

A mile or two, perhaps you will say. Or twenty miles! Or forty miles! Or one hundred miles!

Even on Earth it is often puzzling to tell distances. If one is looking across a smooth surface, with nothing to break it, one cannot easily judge. I remember going in a sailing-boat, as a child, and after a good while saying, "Why, what a little way we have come! The shore looks only a mile or two off!" And I was told that it was at least ten miles off.

You see, there was nothing between to break the smooth water-surface, and so to show how far we had sailed.

If it is perplexing down here on Earth it is much more so up in the Sky. There, nothing lies between to break the great distance; and the stars seem so much alike, except that some are a little brighter and some a little dimmer. One might very easily suppose that the Moon and the Sun and all the Stars were at much the same distances from the Earth.

Yet nothing could be a greater mistake. Some are very near, and some are enormously far away.

That is to say, some are very near compared with others. But even the very nearest is a great deal farther off than fifty or a hundred miles.

Of all bright bodies in the sky, seen day after day and night after night from our Earth, not one ever comes so close as the round silvery Moon.

The Moon is our own especial companion. She always journeys with us, and never goes away.

Before we learn the distance of the Moon we have to think a little about her size. You have not yet learned about the size of our Earth, so we will take the two friends together.

There are two ways of measuring a ball or globe. We may say how big it is *through the middle*, from one side to the other. Or we may say how big it is *round the outside*. The outside measure is always about three times as much as the through-measure.

A large grape may be one inch through, and three inches round outside. A small orange may be two inches through, and six inches round outside. A large apple might be three inches through, and nine inches round outside.

A small cocoa-nut might be four inches through and twelve inches round outside. A school-globe might be one foot through and three feet round outside; or two feet through, and six feet round outside. A balloon might be twenty feet through and sixty feet round outside. Or it might be thirty feet through, and ninety feet round outside.

The through measure is called the *Diameter* of a ball, and the outside measure is called its *Circumference*. A globe may be of any size; and it can be measured according to its size in inches, or feet, or yards, or miles.

Our Earth is a little less than *eight thousand miles* through, from side to side, or from north pole to south pole. Its outside measure, right round the equator, is nearly *twenty-five thousand miles*.

This will not give you any clear idea. It only sounds very large.

Think first of a mile. One mile is a good way for a little child to walk; but not much for a big boy. Some people count five or six miles a very long walk, while others think nothing of ten or twelve miles. Not many men can do as much as thirty or forty miles in a day.

But even fifty miles are only half of one hundred. And it takes ten hundreds to make one thousand. And the through-measure of our Earth is eight thousands of miles.

If that man, whose story you heard in the first chapter, ever had really done as the story says, and walked round the whole world, he would have gone about twenty-five thousand miles!

How long would that have taken him? Certainly very much longer than twenty-four hours. He could not possibly have got along at the rate of one thousand miles and more each hour. The fastest express train does not manage over sixty or seventy miles in an hour.

If he had journeyed all the while, Sundays and week-days alike, twenty miles each day, then he would have got round the world in three years and a half. And if he had only done ten miles a day he would have been nearly seven years getting round.

Of course no man could really cross the oceans on foot; but this will help you to a little notion of what the size of our Earth is.

A very big globe, is she not? yet not truly large, compared with other larger worlds in the sky.

Our Moon is not one of those larger worlds, however.

While the through-measure of the Earth is eight thousand miles that of the Moon is only a little more than two thousand miles. And while the Earth is nearly twenty-five thousand miles

round outside, the Moon is only about six thousand miles.

So if we could put a knitting-needle straight through the Moon, with the ends just showing, one on each side, it would need to be only a quarter as long as a needle to go through the Earth. And a ribbon to fold round the Moon should be scarcely a quarter as long as a ribbon which could be folded just round the Earth.

This makes a good deal of difference in the sizes of the two globes; perhaps more than you would suppose.

I want you now to bring down the Moon, in your mind, to the size of a very small ball; only *one inch* through or *three inches* round outside. Picture her to yourself as getting smaller—and smaller—and smaller, till she is only the size of a very big grape.

Then think of the Earth also, as getting smaller and smaller, just in the same way. Only the Earth must not get so small as the little Moon, in your mind. It must still be four times as long in its through-measure—four inches instead of one inch. And while a little piece of tape, only three inches long, would go just round the tiny Moon, a tape to go round the little Earth would have to be twelve inches long.

Then, if the Moon is about the size of a big grape, or a small walnut, the Earth will be the

size of a very large apple, or of a small cocoa-nut.

It would be a good plan to get a walnut and cocoa-nut of the right sizes, or, if you like, to find two balls, and to place them side by side. The little one must be one inch through, the bigger one must be four inches through. Looking upon them, you will see in a moment how great is the difference between the Earth and the Moon.

I shall often speak of these sizes, so it would be as well to fix them now in your mind, and have them there, ready for use.

Now as to the distance of the Moon from the Earth:

It is about *two hundred and forty thousand miles!*

A rope twenty-five thousand miles long would reach once round the whole Earth, if laid down on the equator.

But a rope to reach all the way from our Earth to the Moon would have to be more than nine times as long as the equator-rope.

You have tried to picture the Earth in your mind as brought down to the size of a small cocoa-nut, and the Moon as brought down to a walnut. In doing this we make one little half-inch do duty for a thousand miles; so that one inch stands for two thousand miles, and four inches means eight thousand miles.

The Moon is two thousand miles through;

therefore a ball or walnut, to picture the Moon, must be one inch through. The Earth is eight thousand miles through; therefore a very big apple or small cocoa-nut, to picture the Earth, must be four inches through.

In the same way we will bring down the distance of the Moon from the Earth. We will let *each thousand miles* of all that space in the sky shrink into a tiny *half-inch*. Then, instead of two hundred and forty thousand miles, we shall only have to think of one hundred and twenty inches, which make ten feet.

So the smaller ball, or walnut, must be put *ten feet* off from the larger ball, or cocoa-nut. That will give you a picture, not only of the size of the earth, compared with the size of the Moon, but also of the distance between the two.

Besides putting the two balls ten feet apart you have to think of them as two little shining worlds.

That is not quite so easy, is it? Why should they shine?

We know that bodies in the sky do shine; but bodies on the Earth more commonly do not. By "bodies" I mean "things." A marble does not shine, nor a grape, nor a walnut, nor an apple, nor an orange, nor a school-globe, nor a balloon.

At least they do not shine of themselves.

Any of them can be made to shine a little, if not much, by being placed in bright sunshine.

Suppose that the two balls—the little imitation-Earth and the little imitation-Moon—were made of glass, or of some smooth metal, such as tin or silver. And suppose you were to hang them up, by wires, out-of-doors, in pitch darkness. Would they shine?

Certainly not. How could they?

But suppose there was another ball, also out in the darkness; a much larger ball, shining with great brilliance, like an electric light.

Would the glass or metal balls show any brightness then at all?

Yes; for the shining of the large brilliant ball would light them up, at least on one side, and would make them bright.

Light is always *thrown back* from a smooth surface. If you have a looking-glass in a dark room it does not shine; but if you hold it in full sunlight it flashes radiantly. Yet the looking-glass has no brightness of its own. It only takes and gives out again of the Sun's light.

That is just how our Earth shines, and how the Moon shines. In themselves both are dull and dark worlds; but, like the looking-glass, they receive radiance from the Sun and give it out again.

Before we go on I want you to be quite

clear in your mind as to what is really meant by this bringing down of large sizes to small sizes. In coming pages you will often hear of it again.

Suppose you have two very large toy-carts, big and heavy. One of them is four feet long and two feet wide, the other of them is three feet long and one foot and a half wide. And suppose that you are trying to explain, to somebody who has not seen them, *how much bigger* one cart is than the other cart.

You may do it by talking, and by showing with your hands about how high they each stand.

Or you may do it in quite a different manner, and much more exactly, by making a kind of little model of each cart—in paper, or cardboard, or wax.

The models would not of course be of the same size as the big carts, but they would have to keep what is called the same *proportion* of sizes. The bigger must still be the bigger; and the smaller must still be the smaller.

You could let one inch stand for one foot. Then the tiny model of the bigger cart—the cart which is four feet long and two feet broad—would only be four *inches* long and two *inches* broad. And the tiny model of the lesser cart—the cart which is three feet long and one foot

and a half broad—would be only three *inches* long and one *inch* and a half broad.

Anybody looking on those two tiny model carts could not possibly tell how big the real carts are. But he could tell one thing. He could know *how much bigger one cart is than the other.*

This is what I hope to show you, by bringing down the sizes of worlds and moons—not how large they really are, but how much larger or how much smaller one is than another.

Also, by this means we learn to understand distances better.

If you are looking at a map of the world, or of a part of the world, the *miles* in that map have to be brought down into a very tiny space. A map of a country, made as large as the country itself, would take up a great deal too much room. So half-an-inch is made to do duty for perhaps fifty real miles, or a hundred real miles, or even a thousand real miles. In quite a small map, a continent or an ocean which is really two thousand miles across might be only one inch across.

And yet, looking at that map, small though it is, you are able to see how near one country is to your own, and how very much farther off another country is.

This is the way in which we are going to think about different worlds — those which are

nearer and those which are farther. We have to make a sort of little map or model of them in our minds; letting one inch always picture two thousand real miles.

QUESTIONS.

1. What is meant by the diameter of a ball?

Its "through measure" from one side to the other, straight through the centre.

2. What is the circumference of a ball?

Its measure round the outside.

3. Which is larger, the through measure or the measure round outside?

The outside measure is about three times as large as the through measure.

4. Give an example or two.

A ball one inch through is about three inches round outside. A ball four inches through is about twelve inches round outside.

5. What is the Earth's diameter?

The Earth is nearly 8,000 miles through.

6. And the Earth's circumference?

The Earth is nearly 25,000 miles round at the equator.

7. What is the Moon's diameter?

The Moon is about 2,000 miles through.

8. And the Moon's circumference?

The Moon is about 6,000 miles round outside.

9. How far is the Moon from the Earth?

About 240,000 miles.

10. How long should a rope be to lie round the Earth on the equator?

About 25,000 miles.

11. How many such ropes would reach all the way from here to the Moon?

About nine such ropes joined together.

12. If we should let one inch stand for 2,000 miles, how large would the Moon be?

A ball one inch through.

13. How large would the Earth be?

A ball four inches through.

14. In that case, how far would the Moon be from the Earth?

About ten feet off.

15. How do the Earth and the Moon shine?

By giving out again, or throwing back, the sunlight which falls upon them.

CHAPTER VI.

THE MOON'S CHANGES.

THE Moon in our sky does not always seem to be of the same shape.

Sometimes she is quite round, like a plump laughing child-face, with eyes and nose and mouth marked in grey shadows. Sometimes a part of the round face seems to be shaven off on one side. Sometimes she is a half-round. Sometimes she is a bright crescent, wider or narrower. Sometimes she is only a slender sickle of light.

Now, how is this? What causes so many changes in the Moon?

You know in what way our Earth shines—as shine she does, if only we were far enough off to see it. You know that she is bright on that side alone which faces the Sun. And you know too that, as she spins daily on her axis, each country in turn comes into the Sun's rays, is lighted up for awhile, then passes away into the night-time of darkness which is on the side of the Earth turned away from the Sun.

And you also know that as the Earth shines so the Moon shines.

The Moon has no radiance of her own. She can only, like a looking-glass, reflect the Sun's radiance. In other words, she receives his light and throws it off again.

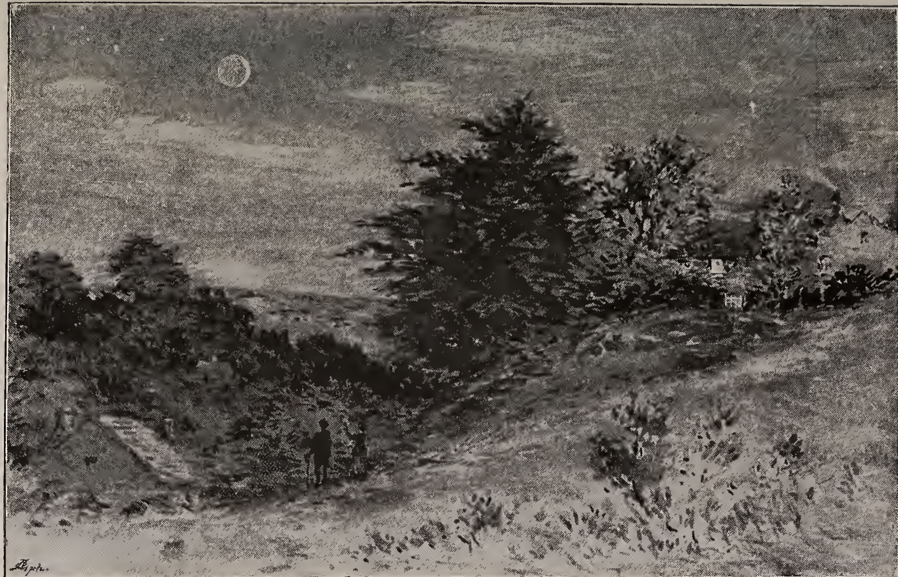
As the Earth spins, so the Moon spins, but very much more slowly. It takes our big Earth only twenty-four hours to whirl once round upon her axis. It takes the Moon about twenty-eight days to spin once round upon her axis.

Only that half of the Moon upon which the Sun shines is bright. Half of her is turned towards the Sun, and this half is bright. Half of her is turned away from the Sun, and this half is dark.

And we from Earth can see, usually, only the *bright* side of the Moon, or just so much of the bright side as happens to be towards us.

Sometimes the whole of the bright side is turned towards us. Sometimes only a part of it, and sometimes none of it is turned towards us.

Now and then we catch a little glimpse of the dark body of the Moon when it is not shining in the sunlight. We see a round dark ball held in the arms of the silver crescent. That is because our own Earth shines so brightly upon the *dark* side of the Moon as to light it up and show it to us. But more often we only perceive the sunlighted side, and the darker part is quite hidden.



The New Moon.

You have noticed the Full Moon, of course, because the Moon then is at her best and brightest. Once a month we always have a Full Moon. It is only on one night that the Moon is really quite full; but for two or three days before and after she is very nearly so.

At Full Moon *the Earth is between the Sun and the Moon.* On one side of our Earth is the Sun; on the other side is the Moon. The Sun shines full upon that side of the Moon which is turned towards us; and so we see the whole of her round bright face. We know that her farther side is in darkness, because it is turned away from the Sun: in almost pitch-darkness, for it has not even our Earth to light it up, being turned away from us also. It has only Stars on the farther side.

I am speaking of when the Sun has set, and is below our horizon, so that we cannot see him, although his rays travel straight to the Moon.

The Sun having set means only that the solid body of our Earth is between him and us. It does not interfere with his shining upon the Moon.

If our Earth at Full Moon were *exactly* between the Sun and the Moon, that would interfere with his shining upon her. More commonly, however, our Earth is not just in the line between, but only very nearly so. Thus

we get the best possible view of the Moon's round face.

The Moon does not stay on one side of the Earth. She is always travelling round from one side to the other side of us. At another part of her monthly journey things are quite different.

A fortnight after Full Moon we have *New Moon.*

At Full Moon the Earth is between Sun and Moon; but at New Moon the Moon has come right round to the opposite side, and is *between the Sun and the Earth.* Not usually in the exact line between, so as to hide the Sun from us, but very nearly so.

Then still the Moon has a bright round face; only we on Earth cannot see it. For her bright side is, as always, towards the Sun; and her *dark* side is towards us.

Just at first we cannot see the New Moon at all, for it is entirely dark. As she journeys on to one side we get a glimpse of a thin line of light shaped like a sickle; and this widens every day. It is while we see the sickle of light that we sometimes catch a glimpse of the dark side of the Moon, dimly lighted up by Earth-shine.

When the Moon gets half-way back to where she was at Full Moon we are able to see *half* of

The Moon. Second quarter. 10½ days old.

her bright face, and we call that the "First Quarter." The other half of the bright face is still turned away from us, and half of the dark side is still towards us. We do not see the whole round face till she gains once more the place of Full Moon—after which, between Full Moon and New Moon, follows the Third Quarter, which is much the same as the First Quarter.

You know that the rising and the setting of the Moon in our sky, by night or by day, are not real movements. They are only seeming movements, caused by our own Earth's daily spinning on her axis.

But these "Phases" as they are called—these changes in the shape and brightness of the Moon—are brought about by her own movements, as she travels round the Earth. She does not actually alter her shape: but she does actually alter her place in the sky, so that we get different views of her from week to week.

The four weeks of the Moon's phases are called a "Lunar Month."

You can make clear to your mind how the changes come about, by acting them out with a lamp and a big ball.

There must be no other light in the room.

Stand first with your back to the lamp and the ball in your hand, held out at arm's length: so that your head is *nearly between the lamp and*

the ball. Not quite between, so as to shade the ball. Hold the ball just a little higher than your head: and the lamplight will fall upon that side of it which is towards your face.

Then you have Full Moon. The lamp is the Sun: your head is our Earth: the ball is the Moon. You see how the lamp lights up the half of the ball which is towards yourself.

Next turn round with your face to the lamp, and hold the ball at arm's length *between your head and the lamp*, only a little higher or lower—not quite in the line between so as to hide the lamp from you. The lamp-light now falls on the other side of the ball; and the dull unlighted side is towards your face.

This is New Moon. Once again the lamp is the Sun, your head is the Earth, and the ball is the Moon. You see how the lamp lights that half of the ball which is turned away from you.

The real New Moon in the sky is invisible. Here you can see the dark side of the ball because the lamplight creeps round it. Still even here you will find a difference between the bright and the shaded parts.

Then, if you hold the ball at arm's length half-way round on one side of your head, you will see how matters are at the Quarters. The lamp still shines full on one side of the ball, but only half of the brighter side is towards you,

The Moon. Third quarter. 16¾ days old.

and half of the darker side. In the real Moon the shaded quarter would be hidden, and only the bright quarter would be visible.

This "quarter" we call "a Half Moon." It is a quarter of the whole Moon, taking the Moon all round; but it is a half of the bright side, which makes our Full Moon.

All that we really know about the Moon's surface is what we see on one side of her. The other side is never turned towards us. No man on this Earth has ever seen it.

A man living on that side of the Moon which we can see might look at all parts of the Earth in turn. As the Earth spins on her axis she turns each side towards the Moon, one after another, in only twenty-four hours. But, although the moon spins, we see only and always one side of her.

If somebody should make his home on the farther side of the Moon, and should never come round to the nearer side, he would not have a glimpse of the Earth. He would see the Sun, because the Sun shines on each part of the Moon in turn: but no Earth would be on his sky. One side of the Moon has a magnificent Moon in the Earth, more than a dozen times as large as our Moon. But the opposite side of the Moon has only starlight when the sun sets.

The reason for this is that the Moon takes

just exactly the same length of time to spin once round on her axis that she takes to travel once round the world: twenty-eight days for the one and twenty-eight days for the other.

Suppose now that you choose to walk round and round a table with a lamp in the middle. You may do it in three different ways.

First: you may spin fast on your feet, like a teetotum, as you go. Each spin of your body may perhaps take a second; and passing slowly round the table may last half-a-minute. As you thus move, each side of your head in turn is towards the lamp with every spin.

Secondly, you may pass slowly round the table in the same manner; not spinning at all but keeping your face fixed on one direction—let us say, towards the fireplace end of the room. Then again, as you move, each part of your head in turn will be towards the lamp.

Thirdly: you may pass round the table turning very gradually indeed upon your feet as you go, turning so slowly that a single spin will last exactly as long as one journey round the table. If you start with your face towards the lamp you will continue to face it all the while, and the back of your head will all the while be away from the lamp, in shadow. In fact, the lamp will never once have a glimpse of the back of your head.

The Moon. Last quarter. 23⅓ days old.

The last of these three is the manner in which the Moon spins on her axis and travels round our Earth.

Such a slow spin brings about a curious state of things. We on the Earth have day and night in every twenty-four hours; but the Moon's day and night come only once in every twenty-eight days. The day there is a whole fortnight in length of our Earth-time: and the night is another whole fortnight.

Fourteen days of blazing sunshine: then fourteen days of pitchy darkness—except for the brightness of the Stars, and except also, on one side, for the beautiful radiance of the Earth.

QUESTIONS.

1. What is meant by the Moon's Phases?

The different shapes of the Moon as we see her in the sky.

2. What kind of shapes?

As Full Moon; as Half Moon; as Crescent Moon.

3. Which part of the Moon shines?

That side which is turned towards the Sun.

4. Do we ever see her dark side?

Sometimes, not far from New Moon, we have a glimpse of it, lighted up by Earth-shine very dimly.

5. Does the Moon spin on her axis?

Yes; but very slowly, only once in twenty-eight days.

6. How long does it take the Moon to get once round the Earth?

Twenty-eight days; the same length of time as her spin.

7. How long is the Moon's day?

About one fortnight of Earth-time.

8. How long is the Moon's night?

About another fortnight.

9. Does the Sun shine on all parts of the Moon?

On all parts in turn, as the Moon slowly spins round.

10. Do we see all parts of the Moon?

We see only one side, because, as the Moon spins, she journeys round the Earth just so fast as to keep one face always in our direction.

11. What is meant by Full Moon?

At Full Moon the Earth is between Sun and Moon, and we have our best view of the full round face of the Moon.

12. Is the Earth exactly between?

Not quite, or she would cut off the sunlight from the Moon.

13. What is New Moon?

At New Moon the Moon is between Earth and Sun, so that her bright side is away from us and we cannot see her at all.

14. Tell me about the First and Third Quarters.

The Moon is then at the side of the Earth, half-way between New and Full. Half only of her bright side is towards us and we see her as "Half Moon."

15. What is a Lunar Month?

A month of four weeks—the time of the Moon's changes.

CHAPTER VII.

THE MOON THROUGH A TELESCOPE.

YOU know how the Moon looks, seen only with our own eyes—a bright round ball, some would say a bright round plate, with odd gray markings which might mean anything. This is about all that can be learned without the help of a telescope. But with the help of a telescope much more can be found out as to our little sister-world.

For a very long while there were no telescopes. Galileo, a famous man, who lived nearly three hundred years ago, was the first who ever made a telescope. Since his time men have learned to make far bigger and better ones; but it was he who discovered how to make one at all.

The Moon, as you know, is really about 240,000 miles away. A good telescope, such as one may often see, lessens that distance to only one thousand or perhaps to five hundred miles. One enormous telescope in California brings the Moon to less than one hundred miles off—some even say to not much more than fifty miles.

You must not suppose this to mean that the telescope pulls the Moon herself nearer. A tube

on earth cannot reach forth and drag towards us a far-off world in the sky.

Did you ever hear of the Irishman who was allowed to look through a telescope at a church in the distance, and who declared afterwards that the church had been brought so near he could hear the organ play!

But this is just what a telescope is *not* able to do. It does not bring a church nearer. It does not bring the Moon nearer. It only makes our eyes able to see *as if* the church or the Moon were nearer. That is all.

It gathers up a great deal more moonlight than our eyes could collect, and so it gives us a larger and clearer view of the Moon from which the light comes.

Yet even at the very best, when the moon is brought, as one may say, within perhaps a hundred miles of the Earth, even then one can only see large things on her surface, not small things. A man who climbs a high mountain gets a wide view all round from the top. He may see perhaps a hundred miles in one direction. But at that distance, and at a good deal less than that distance, he cannot make out much. A mountain or a high hill is pretty clear, perhaps, or the glimmer of a big lake, and a large town would be just visible as a tiny patch or spot. A single house could not be seen at all; far less a horse or a man.

However, though we could not possibly see such small things as these upon the Moon if they were there, we are very sure that no houses *are* there, and no horses, and no men.

And the reason why we are so sure is that the Moon has no air.

A man cannot live without air, because he cannot breathe. Try holding your breath for a little while and you will find how soon you must begin breathing again. If there were no air in your room you would soon die of suffocation. Animals cannot live without air. Even fishes need air in the water to keep them alive. And it seems that there is neither air nor water in the Moon.

No air: or almost none; if any at all, it is so very thin that no living creature on earth could breathe it. No water; no seas or oceans; no rivers and streams. No clouds; for clouds are made of water and float in air. No grass, or plants, or trees; for they too must have air and water. No towns or villages; for they are built by man, and no men can be on the Moon, or women or children. What a dreary place the Moon must be!

It looks dreary seen through a big telescope. It looks dreary also in a photograph. Many photographs are now taken of the Moon.

Such a wild lonely scene we find! Flat deso-

late plains, and mountains with sharp black shadows and clefts and streaks, and a great number of craters in all directions.

You have heard of volcanoes on the Earth. A volcano is a mountain, shaped usually something like a sugar-loaf, with a cup-like hollow near the top. This hollow is called a *crater*: and now and then fire pours from it, with melted burning rocks, or boiling mud, or hot cinders.

In parts of the world there are old used-up volcanoes, which once were very active indeed but which now have no outbreaks. We call these dead volcanoes.

The Moon seems to be half covered with the craters of volcanoes. That side which we always see is pitted over with round holes, big and little--looking in parts almost like a face badly marked with small-pox.

If all these holes really are craters they must belong to *dead* volcanoes; because not a sign is ever observed of any fiery outburst on the Moon. That could easily be seen through a large telescope.

These craters are of all sizes: and many of them have been measured from the earth.

The largest volcano-crater known on the earth is perhaps not more than eight or ten miles across. On the moon there are numbers and numbers of little craters about that size, too

many to count. But there are also many huge craters, far bigger than anything of the kind ever seen here.

Some of the Moon mountains are very high, a good deal higher than Mont Blanc in Switzerland; and they often lie in vast rocky heights around some enormous crater. Such craters are to be seen fifty miles across from edge to edge, and some a hundred miles across, and even more. These monster craters make our little Earth craters seem very small; do they not?

In a photograph of the Moon's surface, taken when she is at her First or Last Quarter, the steep mountains and great craters often stand out very clearly. Of course they do not *look* large to us at this distance, but quite small.

If there were air on the moon her sharp outline and the mountain edges would be much softer than they are now.

The Moon must be a very, very cold world.

True, she is no farther off from the Sun than we are, so his bright rays have the same strength there as here. But she has no thick coverlet of air wrapped round her, to act as a blanket and to keep in the heat which the Sun gives. That is what our air does for us: and that is what the Moon lacks.

Through the long fortnight of darkness, on the side of the Moon which is turned away from

the Sun, the cold must be perfectly awful. But even during the long fortnight of day-time following, when that part of the Moon which has been in darkness gets round into sunlight, things are not much better.

The Sun indeed beats down upon the Moon with frightful power, and with a desperate glare such as we never know on the Earth. For the same air which keeps prisoner the warmth of the sunbeams for our use also softens their glare. But in spite of all this it is likely that the Moon's surface never gets warm—that in the noon of her long day the ground is far more than ice-cold.

On a high mountain-top of the Earth, where the air is thin, although the glare of the Sun becomes fierce yet the ice and snow are not melted. A little thawing of the outermost snow takes place, but often no more than this. When the sun shines through air which is too thin to capture and store up his heat, then he is quite overmatched by the grip of King Frost.

If this is so on the Earth how much more is it likely to be so on the Moon. At the top of the highest Earth mountain there is still a good deal of air, enough for a man to breathe. But on the Moon there is no air at all worth speaking of; not enough to keep alive any creature of which we know.

So, though the Sun does his best, though he floods the Moon with his warmth, all the heat is poured out again just as fast as he pours it in. For want of a sheltering air-coverlet the ground there may remain, and doubtless does remain, ice-cold through all the long Moon-day.

We do not on the Earth see the Stars in daylight. The same thick air which keeps us warm also spreads the sunlight about, and softens black shadows into gray, and turns the sky into a blue depth, and shuts off from our sight the feeble glimmer of stars, and carries to and fro the clouds and mists.

But on the Moon there is no air to form a veil of light; no air to cause a blue sky; no air to spread the sunlight about; no air to make inky shadows gray; no air to carry clouds or mists; no air to hide the stars.

There, in the day-time, in a cloudless deep-black sky shines a dazzling Sun. Not only a Sun, but also a magnificent Earth, hanging like an enormous Moon always in one spot. And not only Sun and Earth, but also countless brilliant Stars, steadfast and untwinkling.

This is a view which a man might have if he could stand on the nearer side of the Moon.

The Sun which he would see would be our Sun. The stars would be the same stars upon which we gaze. The Earth in his sky would be

this world upon which we live. He would see a glorious sight; of that we may be sure. But though our thick moist air does hide the stars by day, and make them twinkle and grow dim by night, think how one would miss the blue sky, and all the pretty changeful clouds which come and go!

Think, too, how dismal a scene it would be around a man standing there! Nothing but dead craters, and bare rocks, and plains without any grass or water, and mountains without any trees. Nothing green, nothing blue, nothing soft or fair, no breaking waves, no trickling streams, no passing showers, no colors, no sounds!

Do you think you would like such a world to live in, even if you *could* live there without any air to breathe? I am very sure that you would soon wish to be back again on our beautiful Earth.

If you were there, you would find one more thing different from what it is here: you would become all at once a great deal lighter in your body.

Just as the Earth pulls everything towards herself so does the Moon also. The mountains and rocks on the moon are dragged moonwards, just as mountains and rocks on the Earth are dragged earthwards. But the pulling there is much less than here, because the Moon is so much smaller than the Earth.

On the surface of the Moon, *downwards* is always towards the centre of the Moon and *upwards* is always towards the sky. All round the Moon it is the same; just as it is on the Earth.

The Moon in our sky is *upwards* to us who live on the Earth. But the Earth in the Moon's sky would be *upwards* to anybody living on the Moon.

QUESTIONS.

1. Who made the first telescope?

Galileo.

2. How long ago?

Nearly three hundred years ago.

3. How near does the biggest telescope seem to bring the Moon?

Perhaps to less than one hundred miles.

4. Could a man live on the Moon?

No; because there is neither air nor water.

5. No air at all?

There may be a very, very little; but much too little for men or animals to breathe.

6. What can be seen of the Moon through a telescope?

Mountains and plains; and a great number of hollows or craters.

7. How high are the mountains?

Some are higher than Mont Blanc.

8. What are the craters?

They are thought to be most likely the craters of dead volcanoes.

9. What shape are they?

Generally more or less round.

10. Are they large or small?

Some are small, only a few miles across. Others are very big.

11. How big are the larger ones?

Some are even a hundred miles across.

12. Is the surface of the Moon hot, or cold?

It is believed to be very cold.

13. In the night, or in the day?

In the day as well as in the night; because there is no air to keep in the Sun's heat, as on the Earth.

14. What other difference would the want of air make?

The sky must be black instead of blue, and the stars must be visible in daylight, and the shadows of the mountains must be very black, not gray, like shadows on the Earth.

15. Are things heavy on the Moon?

Yes; but not so heavy as on the Earth. Though the Moon pulls, she pulls less strongly than the Earth, because she is so much smaller.

CHAPTER VIII.

THE SUN BY DAY.

If you look at the Sun in our sky before he sets, and then, a little later, at the Moon when she has risen, it might seem that the two are very much of the same size and very much at the same distance.

To be sure, the Sun is the brightest; a great deal the brightest. He has such a dazzling face that you cannot look at him steadily. But certainly he does not look larger than the Moon.

What do you think the size of the Sun really and truly is?

Once upon a time people supposed him to be about as big as he looked. And afterwards they fancied that perhaps he might be even as large as a little country called Greece, a much smaller country than England.

But the Sun is bigger than England, bigger than America, bigger than all the oceans of the Earth heaped together; bigger than the Moon, bigger than the whole Earth, bigger than Earth and Moon rolled into one—oh, we are a long way off yet from the truth!

The Sun is a round globe in shape, like the

Earth and the Moon. But he is ever so much larger.

Our Moon, as you know, is about two thousand miles through from side to side. Our Earth is nearly eight thousand miles through. But that enormous globe, the Sun, is — how much do you guess?—is about *eight hundred and fifty thousand miles through!*

Can you picture to yourself what this means? Rather hard, is it not!

The Earth seems so big to us who live upon its surface, and yet she is so small beside the great Sun!

Suppose you had a huge hollow ball the size of the Sun. And suppose you wished to run through that hollow ball a very, very long knitting-needle—eight hundred and fifty thousand miles long—so as just to go from side to side of the huge ball. And suppose upon that big knitting-needle you wished to string a great many Earths or Moons, exactly like our Earth or our Moon, as large beads might be strung close together upon a wire.

How many worlds, the size of our Earth, do you think you would need to reach all through the Sun from side to side? And how many worlds the size of our Moon?

You would want more than one hundred Earths. And if, instead of Earths, you chose to

string Moons on the big needle, you would need more than four hundred Moons.

These would not fill up the enormous hollow ball. They would only reach through in one straight line from side to side, showing the *diameter* of the Sun.

Now try again to think of the Moon as a tiny ball, softly bright on one side, only one inch through; and of the Earth as another ball, shining on one side, four inches through. Think of them, if you like, as a large grape and a small cocoa-nut made of silver.

Then take the same measure for the Sun, letting one little inch do duty always for two thousand miles. The Sun must dwindle and dwindle in size till every two thousand miles in him has become a single inch.

We shall then have a huge ball, or balloon, four hundred and twenty-six inches, or some *thirty-five feet*, through, from side to side.

Thirty-five feet is a great deal more than four inches. *One* foot is twelve inches long.

You have seen many a tall man close upon six feet in height. This balloon, to picture the Sun, must be so large that six tall men might be put inside it, one upon the head of another. The whole string of six tall men would about make the through measure of the globe.

So we have a Moon the size of a large grape,

an Earth the size of a small cocoa-nut, and a Sun the size of a balloon big enough to contain six men in a long row, one upon another. The two little balls would shine softly, on one side only; but the large balloon should be exceedingly brilliant and dazzling all round.

If the Moon is so tiny and the Sun is so huge, how is it that they seem to be the same size in our sky?

Because of the very great difference in their distance from us. The Moon is near; the Sun is far away.

Suppose you are looking at a man near at hand and at a house miles away; which seems to you the bigger? Of course the man, because he is so close. Yet really the house is much the larger of the two.

The Moon is only about two hundred and forty thousand miles off; but the Sun is about ninety-two millions of miles away.

Think what a difference! Two hundred and forty thousands are only a small part of a single million; for a million is a thousand thousands. If you have one thousand beads in a heap, you would need one thousand of those heaps to make a million beads. And when you get to the idea of what is meant by a million, you have to remember that the Sun's distance is ninety-two times *that* number of miles.

After all, we cannot comprehend these figures; they are too bewildering. We may talk of thousands and millions of miles, but we do not *see* them in our minds.

The chief thing to do is to gain some notion of one distance side by side with another: and here the three balls all help us again.

Picture to yourself the tiny Moon-ball, as big as a large grape, and the Earth-ball, as big as a small cocoa-nut; and in your mind put the two *ten feet* apart. There you have the sizes and the distance of the Earth and the Moon brought down from thousands of miles to inches.

Then picture to yourself the Sun, as big as a balloon—the length of six tall men through its middle—and in your mind put that balloon *three quarters of a mile* away from the small Earth and Moon. Somebody will tell you of a house or a place about three-quarters of a mile away from your house, if you ask.

Now do you see how great the difference is between the distance of the Sun from us and the distance of the Moon?

Close upon four thousand feet off, instead of only ten feet off! Almost thirteen hundred yards, instead of a little over three yards! Ninety-two millions of miles, instead of two hundred and forty thousand miles!

The *kind* or *quantity* of difference between

the two is the same, whether we reckon it in inches or feet, in yards or miles, in hundreds, or thousands, or millions of miles.

The Moon and Sun are quite unlike in their way of shining.

Our little Moon has no brightness of her own. She only shines when and where the Sun shines upon her.

But the radiance of the Sun is his own; it is a part of himself. He shines because it is *in* him to shine; it is his nature to shine. He is brilliant all round, not on one side only. If the Sun were destroyed the Moon would shine no longer But if the Moon and the Earth and all the Planets came to an end it would make no difference in the brightness of the Sun.

The Sun's shining is like the shining of the Stars, not like that of the Earth and the Moon: for the Sun himself is a Star; one Star among millions of Stars. He only looks so much larger and brighter than other Stars because he is so much nearer than they are.

Our Earth and Moon are not stars; they are planets, or worlds, travelling round the Sun, and belonging to him. They are not hot bodies, glowing with their own light; but cool and dark bodies, bright only when the Sun shines on them. Moonlight, and also Earthlight—which

we, living on the Earth, cannot see--are both really reflected Sunlight.

There are other planets also, besides the Earth and the Moon, belonging to the Sun: such as Venus, and Mars, and Jupiter. None of these planets are Stars. They are all Worlds.

QUESTIONS.

1. What shape is the Sun?

Like the Earth and the Moon, a globe or sphere in shape.

2. What is the Sun's diameter?

The Sun is about 850,000 miles through.

3. Why do the Sun and Moon seem about the same size in our sky?

Because the Moon is very near, and the Sun very distant.

4. How far off is the Sun?

About 92 millions of miles.

5. What would be the sizes of these three globes, if we let one inch stand for 2,000 miles?

The Moon would be a ball one inch in diameter; the Earth a ball four inches in diameter; the Sun a ball thirty-five feet in diameter.

6. What would be their distances, brought down thus?

The Moon would be about ten feet off from

the Earth, and the Sun would be about three-quarters of a mile from them both.

7. How many thousands of miles make a million miles?

A thousand thousands.

8. How does the Moon shine?

By reflecting Sunlight.

9. How does the Sun shine?

By his own brightness.

10. Which part of Moon and Sun are bright?

The Moon, like the Earth, is bright only on that side which faces the Sun; but the Sun is brilliant all round.

11. Is the Sun a World?

No, the Sun is a Star.

12. Are the Planets Stars?

No; the Planets, like Earth and Moon, are Worlds.

CHAPTER IX.

STORMS ON THE SUN.

THE Sun does not seem to change his shape as the Moon does.

Looking upon him from our Earth, we see always a round shining body. Except when part of him is hidden because it has sunk below the horizon we never have a "half-Sun," or a "quarter-Sun."

Sometimes he is high and sometimes low in the sky; but this is brought about by the Earth's movements, not by any alteration in himself. Sometimes clouds drift between and hide him from us; yet behind the clouds he shines still. Sometimes mists arise and dim his radiance; but beyond the mist his glory is the same. When clouds move on and mists fade, the dazzling globe of light is found unchanged.

There are no shadows on the Sun, like those dull markings which we all know so well upon the Moon.

No shadows, only spots. Yes, the Sun actually has little black spots upon his face, not so very unlike the tiny patches with which ladies used to adorn themselves.

A word of warning here! It is not safe to gaze straight at the Sun, trying to find these spots. When he is low down in the horizon, just before setting, he is not so dazzling, but at other times one ought to be very careful. If you want to look steadily at the Sun you should always use a piece of smoked or tinted glass to soften the glare. Without this you might hurt your eyes, or even in time make yourself blind. When looking through a telescope the danger and the need for care are doubly great.

Dark spots on the Sun are very often to be seen; sometimes only through a telescope, but now and then one is large enough to be seen with no such help—by the eye alone.

It was by means of these spots that the Sun was first found to spin upon its axis, just as our Earth does.

A black spot would be noticed upon one side of the Sun's face. It would be seen slowly to cross over, and to disappear on the other side. Nearly a fortnight would be needed for the journey across, and for another fortnight, or nearly so, the spot would be hidden behind the Sun. After which it would turn up again, on the same side as at first, and in the very same place. Then once more it would travel across and disappear, and in another fortnight it would come round over to its starting-point.

If only a single spot had behaved in this way it might have meant little. But when numbers of spots did the very same thing, time after time, it became clear that the great body of the sun was whirling round, carrying the spots with it.

The Sun, like the Earth, has a north pole, and a south pole, and an equator.

We give the name "north pole" to one end of the axis or line on which he spins, and the name "south pole" to the other end of that axis. And we give the name "equator" to a line exactly round the middle of the Sun, half-way between his two poles.

Most of the spots which we see are somewhere near the Sun's equator, not very near to his north pole or to his south pole.

They come and go and change their shapes, and get bigger or smaller—sometimes slowly, sometimes very fast. A spot may appear and grow and vanish again in one day, or it may stay on for days and weeks, and even months, hardly altering at all, only journeying round and round the Sun.

These things show us that the great Sun spins round upon his axis: and that for each spin he takes about twenty-five or twenty-six days.

But the whirling round of the Sun means no

Day and Night by turns to him, for the whole of the Sun is always light—bright with his own radiance.

Once upon a time it used to be thought that the Sun spots were perhaps *raised* things—dark objects standing high, like mountains. And I will tell you why this idea was given up.

Take an empty cup, and hold it before your eyes, with the open part turned full towards you. The cup must be held as if lying on its side—not with the mouth upwards, as it would stand on a table. You can see, thus, the full circle of the opening, and the whole empty inside.

Next, move it a little way to the right from before your face, turning it slightly away, and you will then see no longer the whole inside, but only a part: and the round opening will have an oval look.

Turn it still further, and you will see a very narrow oval opening, and hardly any of the inside.

Now this is just how the spots seem to behave as they cross the Sun.

When first seen, coming round on one side, they are in shape, more or less, of narrow ovals, and very little of the inside can be seen. As they travel on with the spinning Sun, and get near the middle of the Sun's face, the oval openings widen and grow round, while more of the

dark depths can be seen. Then, passing to the farther edge, they again grow narrow, as at first.

So we feel sure that the spots are hollows or caves, not mountains.

I do not mean such hollows and caves as are found on the earth, but more like the holes that may be seen in a mass of stormy clouds. They seem to be huge rents in glowing Sun-clouds. Usually they have a black centre, with a gray border round the blackness. Now and then, as in the picture of a sun-spot given in this book, the gray part is wanting.

Sun-spots are sometimes larger, sometimes smaller; but none that we see at this distance can be really small. Fifty or sixty thousand miles across is a very common size. Once in a while a spot is more than a hundred thousand miles from edge to edge.

So, though we talk of *little* black spots on the Sun's face, they are not really little, but exceedingly big. And if we were near they would not look black, but fiery.

The Moon's craters seemed big when we first thought of them — fifty or one hundred miles across; very huge beside our tiny Earth craters. These crater-like hollows, however, in the Sun's cloudy surface are fifty or one hundred *thousand* miles across! The whole Moon

dropped into such a hole as this would be a mere little ball in a corner.

The Sun is enormously heavier than our Earth, because enormously bigger. Yet in actual *make* the Sun is light. Instead of being all through as solid as our little Earth, he only weighs as much as if made of something not much heavier than water.

We do not know whether any part of the Sun is really solid and firm. Perhaps not even the innermost parts of that vast globe, certainly not any of the outermost parts. For the heat must be so awful as to turn everything there into gases. Not cool gases, but raging fiery gases, rushing furiously to and fro.

Over the whole brilliant body of the Sun is spread a mighty ocean—not of cool water, like our seas, but of crimson fiery gas-waves. And out of this ocean spring crimson mountains of fiery gas. And beyond these jagged mountains—little, as seen from the Earth, but really of great height—lies a beautiful and wide-spreading wreath of pearly light, called "The Corona," or, "The Crown."

The bright face of the Sun and its tiny black spots can be easily seen from the Earth. But the crimson sea, showing as a red border round the edge, and the fiery mountains, and the crown of light, are very seldom to be seen.

When an eclipse of the Sun happens, then for a few seconds they are clearly visible to people with telescopes.

Besides the black spots and the red mountains, bright white spots are sometimes noticed.

Also another curious sight is often seen, in a telescope. Countless little long narrow objects, something like willow leaves or grains of rice, seem to lie scattered closely over the sun. They are either side by side or crossing one another. Look at the picture of the sun-spot, and you will see the "willow leaves" there. Perhaps they are shining sun-clouds.

Awful storms are common on the Sun, and terrific outbreaks are often taking place. Wild rushes of blazing gases can be seen, even from this great distance. The black spots are most likely caused by vast whirlwinds tearing open the Sun's bright envelope of clouds; and the white spots may be another kind of tornado.

Doubtless the crimson fire-mountains are also some sort of storm. They come and go, change and disappear, in a longer or a shorter time. Fifty thousand miles of height is common for one of them, and a hundred thousand miles is not unusual, and often they are still more.

Our very highest mountain on the Earth is only about seven miles high. Think what a difference!

But you must not picture to yourself solid mountains of rock on the Sun. All rock there is not melted only, but turned to gases, by the tremendous heat. These crimson heights are of gases, glowing and brilliant.

It is pretty safe to say of the Sun, as of the Moon, that people such as we are could not possibly live there. If the Moon is too cold, the Sun is infinitely too hot. If the Moon has no air, the Sun has certainly none of the right kind for men and animals to breathe. Besides, how could they exist on a globe of fiery gases?

We know pretty well what the burning power of the Sun is, even here, on a hot summer's day, as he shines out of a cloudless sky. But this is ninety-two millions of miles off!

Imagine what the desperate heat and glare must be at a distance of only a few thousand miles; not to speak of close to the Sun!

If our Earth were to journey to a place in the sky as far away from the Sun as our Moon is now from us, one of those fiery mountain-tongues of crimson gas might leap out and wrap itself round the whole Earth. But long before she could get so near she would have become a tomb of death—scorched, and dried up, and withered. The seas would all have turned into hot steam, and not a blade of grass would be left.

Yet, although, if we could venture near, we

should be destroyed, on the other hand we owe much to the Sun. Did you ever think what a dark and cold and lifeless globe our Earth would be without him?

All our light, except a few star-glimmers, comes from the Sun. Even moonlight is really reflected sunlight.

Almost all our heat comes from him. Once upon a time the Earth was hot and glowing, and some heat still remains deep underground even now. But this heat could do little for us if the Sun were absent. You know how icy-cold the ground becomes in winter.

Still, you may say, we have fires to warm us, and lamps and candles to give us light.

But how could we have either without the Sun? His rays cause the trees to grow from which we obtain our wood. His warmth in the long past made those forests grow which were afterwards buried under ground and became coal. When we burn coal and wood they give out again the heat which once they borrowed from the Sun.

Without the Sun there could be no oil for lamps, no tallow or wax for candles. Nothing would live, nothing would grow. Our Earth would be a dead world like the Moon, fixed and changeless.

True, the Sun shines upon the Moon as upon us; and there he can do little, because air and

water are wanting. *With* air and water for his useful servants he can do much. But air and water without the Sun could do nothing at all—in fact they would be air and water no longer.

So we can trace gratefully to the Sun all the heat, the glow, the light, the life, the growth, that we find on Earth. And one step farther brings us to the thought of OUR FATHER IN HEAVEN, who created the Sun, and who appointed it to be our storehouse of Heat and Light.

QUESTIONS.

1. Has the Sun phases like the moon?

No, he always appears round in shape.

2. Has the Sun gray markings?

No, but he has dark spots.

3. Are the spots large, or small?

They seem small to us at this distance, but they are really large.

4. What size are they?

Fifty thousand miles across, or a hundred thousand miles across, are not uncommon.

5. How was the Sun first found to spin round?

By the movement of spots across his face, from one side to the other.

6. What is the length of the Sun's spin?

He spins on his axis once in about 25 or 26 days.

7. Where are spots more often seen?

Not far from the Sun's equator.

8. Do the spots remain long?

A spot sometimes comes and goes in one day. Other spots stay for weeks, and even months.

9. What are the spots believed to be?

Holes torn by storms in the Sun's covering of bright clouds.

10. Is any other kind of storm seen on the Sun?

Sometimes white spots are seen.

11. Is the Sun heavy in make, or light?

Not much heavier than water.

12. What can be seen in an eclipse which is not seen usually?

A crimson ocean of gases, mountains of fiery gases, and the "Corona," or Crown of light.

13. How high are the gas-mountains?

Sometimes fifty thousand or a hundred thousand miles high.

14. Are they always the same?

No; they come and go and change, like the black spots.

15. Is it likely that men could live on the Sun?

It seems quite impossible, the sun being in a state of raging heat.

16. Do we owe much to the Sun?

All our light and heat. Without the Sun our world would be a dead world.

CHAPTER X.

HOW THE WORLD JOURNEYS.

YOU see now how it is that on the Earth we have day and night. The whole Earth spins round and round, and so each part of her in turn comes into sunlight.

This is not the only way in which our Earth moves. She also journeys round and round the Sun, revolving always on her axis every day as she goes.

A year on the Earth is about three hundred and sixty-five days long, or twelve months. Our "year" means just that time in which the Earth travels once round the Sun. And in that year, as she journeys, she turns right round upon her axis three hundred and sixty-five times.

So there are two separate movements of the Earth. A boy may, if he likes, stand still, and spin round like a top. Or he may walk round the table without spinning. Or he may do the two things together: he may walk round the table, and as he goes he may keep spinning like a top. That is how the Earth goes round the Sun.

As she moves she is always at much the same distance from the Sun—about 92 millions of miles off. In one part of her pathway she is a little farther, and in another part a little nearer; but there is never very much difference.

Sometimes she is on one side of the Sun, sometimes on another side. Always, day after day, and year after year, she keeps steadily journeying round and round the Sun.

This is how we get our seasons upon Earth. Spring is followed by summer, summer by autumn, autumn by winter, winter by spring again. It is on and on, the same thing, year after year.

In an earlier chapter you heard about the Equinoxes and the Solstices. There is an Equinox in the spring, a Solstice in the summer, an Equinox in the autumn, and a Solstice in the winter. At each of these times the Earth is in a different part of her pathway round the Sun. Also she is differently *placed.*

It is of course quite clear to you by this time that our Earth is a round solid globe in the sky. Also that the axis of the Earth is a straight line from her north to her south pole, right through the middle of her.

Now I want you to understand that, as the Earth goes round the Sun, her axis *leans over a*

little in one direction, and always in the same direction.

Have you a good-sized soft ball to picture the Earth? Stick a big bonnet-pin right through the middle of it; that pin is the Earth's axis. The pin's head shows the north pole, and the pin's point shows the south pole.

Properly, of course, if this little Earth is about four inches through in size, it ought to travel round and round a huge shining balloon, three-quarters of a mile off, to show how the Earth goes round the Sun.

But this, I am afraid, you will hardly be able to manage. So you must let distances alone, and just have a candle or a lamp on a table, and learn with that how we get our summer and winter.

First, now, hold the ball on one side of the candle. Let its north pole—the pin's head—point in a sloping way *over* the candle-flame; not exactly towards the candle, and not up straight towards the ceiling, but in a slant.

This means Summer for the northern half of your little world, and Winter for the southern half. You must notice carefully how the north pole is towards the candle and the south pole is away from it. So, at the same time, we in the north have our Summer Solstice and people in the south have their Winter Solstice.

Next, carry round your ball to the other side of the candle, just opposite to where you have been; but do not turn it in your hand as you go. The *slant* or *lean* of the pin must be the same; and the pin's head must point still just where it pointed before. You will see now that the south pole is towards the candle, and the north pole is away from it.

This means Summer for the southern half of your little world, and Winter for the northern half. So we in the north have our Winter Solstice while friends in the south have their Summer Solstice.

Between Summer and Winter lie the Spring and the Autumn Equinoxes.

For either of these you must carry your ball to one side of the candle, half-way between the summer place and the winter place. Your pin must still slant exactly as it did before, with no change in the direction of its head.

You will then find neither north pole nor south pole towards the candle. The pin lies *sideways* to it, and the candle-light falls on both poles alike. So here, as the Earth spins, days and nights are of just the same length; and this is one of the Equinoxes.

Over the greater part of the Earth days and nights are always altering in length between the Spring Equinox and the Autumn Equinox.

Days are getting longer and nights shorter; or nights are getting longer and days shorter.

In the very far north, and in the very far south, near the poles, things are different. There, when the pole is turned towards the Sun, one full day lasts for months, with no sunset. And there, when the pole is turned away from the Sun, one full night lasts for months, with no sunrise.

Some chapters back we were thinking about our Earth as she floats in the sky, with stars all around her everywhere. You heard how the stars seem to travel every night across the sky, and how this seeming journey of theirs is brought about by our own Earth's daily spinning on her axis.

The stars which we see in our sky are not exactly the same all the year round. Some are the same, but some are different. Fresh star-groups come into view in the evening at one time of the year, and vanish again at another time.

This is because we can only see those stars which lie in a direction *away from the Sun.* It is impossible for us to see those which lie *beyond the Sun;* for they are above the horizon when he is above it, and their faint glimmers are quite hidden by his radiance.

As we go round the Sun, we see him month

by month in a fresh part of the sky, and behind him lie fresh star-groups. So our journey makes the Sun seem to move among the stars, and the Sun's seeming pathway we call the Ecliptic.

As the Earth travels, her north pole always points exactly in one direction—always *towards the Pole-star*.

If a man were standing at the north pole and looking upwards, he would see the Pole-star always, at any hour of the night, in just the very same spot.

When we think of our Earth as a globe floating in the sky, we must try to remember that in the Sky there is no real "up" or "down." This you have heard before.

Our "up" is always towards the sky, and away from the ground. But as the Earth turns round and round our "up" is every hour in a fresh direction.

For the blue heaven is all around us, and from every part of the Earth we look up into the depths of the sky.

We speak of some stars being in the "northern sky," and of other stars being in the "southern sky." For our own use we have given the name "northern sky" to one part of the heavens, and the name "southern sky" to another part.

Only "north" does not mean up," and south does not mean "down." The only true "up" for us is from any part of the Earth where we may be towards the sky over our heads, and the only true "down" is towards the middle of our Earth, under our feet.

QUESTIONS.

1. What is a Year?

The time that our Earth takes to journey round the Sun.

2. How long is the Earth's Year?

Twelve months, or about 365 days.

3. How many times does the Earth turn round on her axis in one Year?

Three hundred and sixty-five times.

4. What is meant by the Seasons?

Spring, Summer, Autumn and Winter.

5. How are the Seasons caused?

The Earth travels round the Sun with her axis slanting.

6. How does it slant?

Always in one direction, with her north pole pointing to the Pole-star.

7. What brings summer to us in the north?

When the Earth is on one side of the Sun

her north pole is towards the Sun, and the northern half of the Earth gets most of his heat and light.

8. What brings winter to us?

When the Earth gets round to the other side of the Sun her north pole is turned away from him, and so we in the north have less heat and light.

9. Do they have summer and winter in the south of the world?

The southern half of the world has summer when we have winter in the north, and winter when we have summer in the north.

10. How is this?

When the north pole is towards the Sun the south pole is turned away, and when the north pole is away from the Sun the south pole is towards him.

11. When are the Equinoxes?

In Spring and Autumn, half-way between Summer and Winter.

12. In which part of the world is the Equinox?

All over the world at once.

13. Which pole is then turned towards the Sun?

Neither pole. The Earth's axis is then side-

ways to the Sun, and his light falls on north and south pole alike.

14. What is the Ecliptic?

The path which the Sun seems to take in the sky through one year.

15. Where would a man at the north pole see the Pole-star?

Always exactly overhead.

CHAPTER XI.

OTHER WORLDS.

Now for the Planets, or Worlds, which journey as our Earth journeys, round and round the Sun, each in its own particular pathway. And—to begin with—a few words as to what keeps them in their pathways.

Two things working together do this. There is an inward pull, and there is also an outward pull.

The inward pull is the pull of Attraction, known also as Gravitation. You have heard a little about Attraction before. You know how the Earth pulls, with a steady downward drag, everything upon her surface. And in just the very same manner the Sun pulls towards himself all the worlds, little or big, which float around him in the sky.

When you try to jump up from the Earth you drop back. It is impossible for you to get right away, merely by jumping, because of the Earth's strong pull.

And if our Earth tries to get away from the Sun, she cannot do so either; because of the Sun's strong pull. In fact she is always trying and never succeeds.

She is always trying to get away because she is always on the rush; always hastening at a great speed, and struggling to go straight forward in her rush, while the pull of the Sun keeps drawing her out of a straight line and making her travel in a bent path round the Sun.

If it were not for the Earth's rapid onward movement she would soon fall down upon the Sun; and if it were not for the Sun's pull she would soon wander away from him. These two things—the inward pull of the Sun's attraction and the outward pull of our Earth's own quick rush—keep her at her present distance from the Sun.

It is the same with the other Planets. They too journey round the Sun in oval pathways. Those worlds which are nearer to him are pulled more strongly; and they have to fly along at a great speed, to escape from falling down upon his fiery surface. Those which are farther off are pulled more feebly; and they move at a much slower pace.

When "attraction" is spoken of, remember that it is always a pull on both sides. The Earth attracts the Sun, as well as the Sun attracting the Earth; and all the Planets attract one another. But the pull of the Sun is so powerful that other pullings seem small by comparison.

Our world is only one little planet in the great Kingdom of the Sun. That kingdom is commonly called "THE SOLAR SYSTEM."

A "system" means something which is arranged, or which is made up of different parts put together in an orderly manner. The word "solar" is from the Latin for "Sun." So, by the Solar System we mean that great System or Arrangement of Worlds which is governed by the Sun.

No two worlds are at the same distance from the Sun; but all the larger planets travel on very much the same *plane*—that is, on the same level, or the same *flat*, in the sky.

Also, they all go the same way. They journey round the Sun from west to east; not from east to west.

Astronomers have sometimes fancied that they could catch a glimpse of one small world very near to the Sun, which they named VULCAN. But it is very doubtful whether there really is any such planet at all. If there is, he is almost lost in the glare of the Sun.

The nearest to the Sun of which we know positively is named MERCURY.

He is much smaller than our world, though larger than our Moon; and he whirls along at a dizzy speed.

Outside the pathway of Mercury, like a large

hoop round a little one, only at a good distance off, lies the oval-shaped pathway of VENUS.

Though we often speak carelessly of this lovely world as "The Evening Star," Venus is no star, but a planet like the Earth, shining only in the Sun's light. And, although perhaps not really brighter in herself than all other worlds, Venus is by far the brightest in our sky.

Mercury's pathway lies too close to the Sun to give us often very good views of him. Besides, Mercury is not only much smaller than Venus, but much farther away from us.

That is to say, Mercury at his nearest is farther off from us than Venus at her nearest. When Mercury happens to be between the Sun and us, while Venus happens to be far away on the other side of the Sun, just then, of course, Mercury for a little while is the closer to us of the two.

If you have three hoops of different sizes you will be able to see quite easily how this comes about.

Lay the hoops on the floor, one within another, and place a ball in the middle for the Sun. Then lay one marble, for the Earth, close to the outermost and largest hoop, and another marble for Mercury, close to the innermost and smallest hoop, on the *same side* as the Earth-marble.

Then put a marble, for Venus, close to the middle-sized hoop, still on the same side.

So the three worlds are all together on the same side, as near as they ever can come one to another. And you will see that Mercury can never get so close to the Earth as Venus can.

But now, leaving the Earth and Mercury alone, move the Venus-marble half-way round its hoop, to just the opposite side of the Sun. You will then understand how sometimes, for a little while, Venus may be actually much farther off than Mercury from our Earth.

These worlds all travel on different pathways at different speeds, and the pathways are not of the same length. So the worlds never keep long side by side. For a little while they may journey in company; then one gets ahead and the other drops behind. By-and-by they are on opposite sides of the Sun; and then in time they draw near one to another again.

Both Mercury and Venus have *phases*, or seeming changes of shape, like our Moon. They shine only on one side, that side which is towards the Sun; and sometimes we see only part of the bright side, not the whole of it. But the changes are too small at such a distance to be seen without a telescope.

Venus is very nearly the same size as our Earth. She lies farther from the Sun than Mer-

cury, and nearer the Earth. This means that she has more light and more heat than we have, but less light and less heat than Mercury has. From Venus the Sun looks very much larger and more brilliant than we see him, yet much smaller and less brilliant than as seen from Mercury.

Also, the Sun pulls Venus more strongly than he pulls the Earth, but less strongly than he pulls Mercury. Venus does not journey so fast as Mercury, but she goes farther than our Earth goes.

You see how perfectly these things are all planned, so as just to fit in one with another. We may well talk of our Sun's kingdom in the sky as a *System*, when we find its wonderful arrangements and note the order and beauty of the whole.

The two inner worlds, Mercury and Venus, are called "Inferior Planets," because they lie between the Earth and the Sun. All other worlds, having pathways outside our Earth's pathway, are called "Superior Planets."

The next oval hoop which surrounds the pathway of Venus is that of THE EARTH.

Outside the pathway of our Earth lies that of MARS: another world, a good deal smaller than the Earth or Venus, but larger than Mercury.

Both Mercury and Venus can only be seen in

the sky near to the Sun, either a short time before he rises in the morning, or not long after he sets in the evening—either towards the east in the morning, or towards the west in the evening. But Mars and all the other outer planets may be seen in various parts of the sky at different times.

Of these four small Worlds our Earth is the largest, being nearly 8,000 miles straight through from side to side.

Venus is the next in size, being nearly as large as Earth.

Mars is the next, being about 4,000 miles through.

Mercury is the smallest, being less than 3,000 miles through.

And our Moon, as you know, is smaller still, being only 2,000 miles through.

Suppose we look upon these worlds, as we have done earlier, in a lessened size; letting one inch stand for 2,000 miles.

Then to picture our Moon we should want a very large grape, or a small walnut, one inch through.

Our Earth would be a very big apple, or a small cocoa-nut, four inches through.

Venus would be another big apple, almost as large as the Earth.

Mars might be a small orange, two inches through.

Mercury might be a crab-apple, only one inch and a half straight through.

If you can manage to find five balls of the right sizes, and put them all in a row, you will get a very fair idea of the sizes of these worlds, as *compared* one with another.

Try also to fix the names firmly in your memory, by saying them often over and over—"Mercury, Venus, Earth, Mars."

Remember that "Earth" is the name of our world, just as "Venus" is the name of another world. All the planets are "worlds," but only one of them is "Earth."

After Mars comes a wide space in the heavens, which for a long while was thought to be quite empty of worlds. But it is not empty. Instead of one big planet a great many tiny ones are there, journeying round the Sun in company. Nearly three hundred and fifty are known to us, and fresh ones are still often found.

When first discovered, about one hundred years ago, these small worlds were named ASTEROIDS, or Little Stars. Now they are known as PLANETOIDS, or Little Planets. This is the right name for them, since they are not stars but planets, or worlds.

Only they are very, very tiny worlds. The biggest of them all is under 400 miles through; and most of them are much less. So if the Moon

is pictured by a large grape, a pea would be far too big for most of the Planetoids.

This belt of Planetoids comes after a broad gap of space, between it and Mars; and it is followed by another wide gap.

Then we get to the pathway of JUPITER.

Here indeed is a contrast. The Planetoids are the smallest worlds in the whole Polar System, and Jupiter is the largest. He is very, very far away; yet, as he shines in our sky, he is often the most splendid object we can see there, second only to Venus.

Venus is very much *smaller* than Jupiter; but Venus is also very much *nearer* than Jupiter.

Not one of all the other planets is as big as Jupiter. While our Earth is only eight thousand miles through, Jupiter is eighty-five thousand miles through. This makes a wonderful difference. Jupiter is very small beside the Sun, but he is very huge beside our little Earth.

Jupiter's speed is far slower than that of the inner planets. At his vast distance the pull of the Sun is much weaker, and so he does not go so fast.

If Jupiter whirled round the Sun as fast as Mars does the Sun could not hold him in, and he would wander away and be lost. But if Mercury were to journey at Jupiter's pace he could

not keep away from the Sun, and he would, most likely, soon be destroyed.

Jupiter does not travel alone. He has a family of moons; not one only, like our Earth, but five moons, the nearest of which has been quite lately found. These moons all journey with Jupiter round the Sun; and they also go round Jupiter as our Moon goes round the Earth.

Beyond Jupiter, at a great distance, is another giant world, SATURN. Not quite so big as Jupiter, but not very far behind him in size.

Saturn too has a family, not of five moons only but of eight moons. He also has three very wonderful rings, which shine in the sunlight. Neither rings nor moons can be seen without a very good telescope.

Outside the pathway of Saturn lies that of URANUS, another huge world, though a good deal smaller than Saturn.

Outside the pathway of Uranus travels the dim and distant NEPTUNE—so far as we know, the outermost world of the whole Solar System. Neptune is rather larger than Uranus.

So there are first the four smaller or Lesser Planets—Mercury, Venus, Earth, Mars; then the Planetoids; and then the four big Outer Planets—Jupiter, Saturn, Uranus, Neptune.

Now look again at your little balls which picture the sizes of the smaller planets. The

biggest of them is our Earth—a ball or a cocoa-nut four inches through.

But when we turn to Jupiter, still letting one inch stand for 2,000 miles, we shall want a ball or globe no less than *three feet and a half* through, from side to side.

And for Saturn we must find a globe *three feet* through.

And for Uranus a globe less than *one foot and a half* through.

And for Neptune a globe quite *one foot and a half* through.

Then, to finish up, we shall want a big balloon, for the Sun, *thirty-five feet* through.

QUESTIONS.

1. What is the Solar System?

The Sun's Kingdom of Worlds in the Sky.

2. What is a System?

An orderly arrangement.

3. What is a Planet?

A planet is a world which shines by borrowed light.

4. What is an Orbit?

A planet's pathway.

5. How do the pathways of the planets lie round the Sun?

One outside another, and all of them very nearly on the same level.

6. Which are the four Lesser Planets—nearest to the Sun?

Mercury, Venus, Earth, Mars.

7. What comes next?

The belt of tiny Planetoids.

8. Which are the four Outer Planets?

Jupiter, Saturn, Uranus, Neptune.

9. Which is the largest planet of all?

Jupiter.

10. If our Earth were only four inches through how big should Jupiter be?

Three feet and a half through.

11. How many moons has Jupiter?

Five moons.

12. How many moons has Saturn?

Eight moons, and three rings.

13. Which planet is nearest to the Sun?

Mercury.

14. Is this quite sure?

An inner planet, Vulcan, may be there; but this is very uncertain.

15. Which is the farthest off planet known to us?

Neptune.

16. How many Planetoids do we know of?

Nearly 350; and new ones are often found.

19. Which planets travel fastest?

Those nearest to the Sun.

20. Why do they travel faster?

Because the pull of the Sun is so much stronger.

21. In what direction do the planets travel?

All of them from west to east.

22. Which way do they spin?

All of them from west to east.

CHAPTER XII.

WHAT IS MEANT BY AN ECLIPSE.

Before telling you more about the other worlds in the Sun's kingdom I should like you to understand what is meant by an Eclipse.

The word "Eclipse" really means "a failure"—as when something *fails* to shine because its light is somehow hidden or shadowed.

First, we will think about an Eclipse of the Sun.

For this we will forget all other worlds, and fix our minds only on the Earth, the Moon, and the Sun.

The Sun is in the centre, or, as a child would say, "in the middle." The Earth journeys round him. The Moon also journeys round the Sun; and, as she goes, she curves backwards and forwards, so as to be on each side of the Earth in turn.

Sometimes she is outside the Earth, away from the Sun; and then we see her as Full Moon. Sometimes she is between the Earth and the Sun—only a little higher or lower, and not exactly between—and then she is New Moon, with her bright face turned from us, so that we cannot see her.

Suppose the Moon, instead of being at "New Moon" a little higher or lower, were to pass just *exactly* between the Sun and us; what would happen?

We should see her as a dark round body, creeping over the face of the Sun, and hiding him from us.

And this is precisely what we do see, from time to time. Once in a while the Moon does come into the line between; and then we have an Eclipse of the Sun: we see the moon's dark body covering or partly covering his face.

You must not think that the Moon is at such times any darker than usual. She always has a dark side and a bright side. At New Moon the dark side is towards us, and so we cannot see it at all—*unless* she happens to be just between the Sun and us.

But you must not suppose for a moment that she really touches the face of the Sun. The Moon is no nearer to the Sun than usual. She is only *between* him and us.

If you are in a room with a lamp on the table, and somebody holds a big ball just between your eyes and the lamp, what happens?

The lamp is eclipsed. It does not leave off shining, but to you it is eclipsed, or hidden. You see the dark ball, not the bright globe of the lamp beyond it.

That is how we have an eclipse of the Sun. Now and then, at New Moon, our Moon glides exactly between, just as the ball came between your eyes and the lamp. And then the light of the Sun is cut off from part of the Earth.

An eclipse of the Sun is always known about beforehand. The Moon's pathway and the Earth's pathway are so well understood by astronomers that they can tell when she will pass a little higher, or a little lower, and when she will go just between, so as to eclipse the Sun.

Then, when the moment comes, we look earnestly at the Sun, perhaps with telescopes, perhaps only with pieces of smoked glass to protect our eyes; and we see—

A dark round body touching the bright side of the Sun, then slowly crossing his face and blotting out his radiance.

Not that the Sun is dimmed, or that for a moment he leaves off shining. Other worlds see him still, as brilliant as ever. But to us, for a short space, his light is hidden by the solid Moon floating between.

For a few seconds, and no more, we have almost darkness. Then, on the side of the Sun where the moon seemed first to touch him, a line of light is seen. This widens fast, as the dark round moon draws away to the opposite

edge and then vanishes, and the whole Sun shines out as usual.

Even when an eclipse can be seen it is often only a *Partial* eclipse, not *Total*. Only part of the Sun is hidden, not all of him. The Moon creeps over one edge, or perhaps over half of the Sun's face, but she does not cover him quite.

Now and then we have what is called an *Annular* eclipse. The round dark body of the Moon is seen upon the face of the Sun, and a bright rim of the Sun is all round the Moon.

It seems odd that at one time the Moon should quite hide the Sun, and that at another time the Moon should be too small to hide him.

The reason is that the Moon is sometimes a little nearer to us, sometimes a little farther away; and the Sun too is the same—sometimes a little nearer, sometimes a little farther.

If an eclipse happens just when the Moon is at her farthest from us, and so seems her smallest, while the Sun is at his nearest to us, and so seems his biggest, then she is not large enough to cover his whole face. But if the Sun is at his farthest, and the Moon at her nearest, she can hide him entirely.

When a Total Eclipse is foretold, astronomers are eager to make the most of it. Telescopes are pointed at him, and photographs are taken. Much can be seen during a total eclipse

which is hidden from us at other times, because the dazzling brilliance of the Sun's body is for a few seconds cut off from our eyes.

The ocean of fire round the Sun is seen at his edge, outside the dark body of the Moon, by those who look through telescopes; also the sharp mountains of fiery gases, and the soft broad crown of light spreading away on all sides.

But the very utmost has to be made of each moment. Hardly has the Moon's body covered the whole face of the Sun before she begins to move away from the side which first she seemed to touch; and as a bright line of light appears there, these wonderful sights vanish.

Remember, an Eclipse of the Sun never happens except at the time of New Moon. It is only then that the Moon can possibly be just between the Sun and our Earth.

Another kind of Eclipse, however, may happen at Full Moon; and that is an eclipse of the Moon herself.

An Eclipse of the Moon is partly like and partly unlike an Eclipse of the Sun.

In an Eclipse of the Sun we have the solid body of the Moon gliding in between, and hiding his light from us though all the time the Sun shines on just the same, behind the Moon.

At 9 : 32.

At 9 : 37.

Eclipse of the Moon. January 28, 1888.

In an eclipse of the Moon we, on the Earth, have no solid body between us and the Moon. Her brightness is not simply hidden, it is for the moment quenched by a shadow. For the shadow of our Earth falls upon her.

The Moon is bright only when the sunshine makes her bright. When the solid body of the Earth, gliding in between, cuts off the sunlight from her, then the Moon shines no longer. So long as she is plunged in the Earth's shadow she is all dark.

You have seen with a lamp and a big ball how the Sun can be eclipsed by the Moon.

Now, instead of letting some one hold the ball between your head and the lamp, you must get some one to hold the ball farther off while you move *with your head between the lamp and the ball.* Place your head exactly between, so that its shadow covers the ball.

Then you have a picture of a Moon-Eclipse.

So once in a while, when the Earth goes exactly between Sun and Moon, the Moon for a very short time is not a bright world at all. She is quite a dull one. But the very moment she catches a glimpse of the Sun's radiant face she begins to shine again.

There is, you see, a great likeness, as well as some difference, between an Eclipse of the Sun and an Eclipse of the Moon.

In an Eclipse of the Moon the Earth glides between Sun and Moon, and the Moon passes into the Earth's shadow. In an Eclipse of the Sun, the Moon glides between Sun and Earth, and a part of our Earth passes into the Moon's shadow. The Earth's shadow is large, and the Moon's shadow is small; yet so far the two kinds of Eclipse are really alike.

If you and I were standing on the Sun we should see the Earth eclipse the Moon, and the Moon eclipse part of the Earth, by turns, and in the same way. The Earth would slip in front of the Moon, hiding the Moon from us; or the Moon would slip in front of the Earth, hiding part of the Earth from us.

But looking upon the two sights from the Earth, and not from the Sun, they seem to us a little different in kind.

Other Eclipses take place in the kingdom of the Sun besides these two.

There are many other moons besides our Moon. You should always remember that MOON is the name of our particular moon, just as EARTH is the name of our particular world. Other little worlds travelling with big ones are spoken of as "moons;" but more rightly they ought to be called "satellites." Each one has its own separate name; whereas *our* "satellite" has no other name except "The Moon."

At 10.

At 10 : 15.

Eclipse of the Moon. January 28, 1888.

Mars has two tiny moons, and Mars often eclipses his moons. Jupiter has five moons, and they often pass into his vast shadow. The eight moons of Saturn, the four moons of Uranus, the moon of Neptune, are all in turn eclipsed. Also, in turn, they all pass between the Sun and the Planet to which they belong, casting a small shadow on the Planet, and making an Eclipse of the Sun for that part where the shadow falls.

One or two other things often seen are much like Eclipses, though known by other names.

For instance, as the Moon journeys at night across the sky—*seems* to journey, I mean—she blots out star after star on her way.

Does she really blot each star out, as you might snuff out a candle?

No, indeed. She only comes between our eyes and the star. The Moon is still as near as usual, and the star beyond is as far off as usual. But, for a little while, the Moon, being exactly in the line between, hides the star from us.

We do not speak of this as an eclipse, but really it *is* an Eclipse of the stars by the Moon.

They are hidden by the solid body of the Moon, just exactly as the Sun is hidden during a Total Eclipse. The chief difference is that we look upon the bright side of the Moon, instead of the dark side.

Again, you will sometimes hear of a CON-

JUNCTION of two planets, or of a planet and a very bright star.

A "Conjunction" means "a joining together."

Jupiter is seen, in the sky, to come very close indeed to Saturn. We are told that it is "a Conjunction" of Jupiter and Saturn.

Still you must not for a moment think that Jupiter is any closer than usual to Saturn. They are divided, as always, by a great gulf of millions upon millions of miles. The two only happen to be for a while in nearly the same *line of sight*, as looked upon from the Earth. Saturn is very much farther off, but he is almost *behind* Jupiter.

Instead of Jupiter and Saturn seeming to draw near together, it may be Jupiter and Venus; or perhaps Jupiter and Mars; or Saturn and the bright star Sirius.

But in each case it is only a seeming nearness. They are not really near together. It is only a matter of the one being seen *beyond* the other—very greatly beyond it—in almost the same line of sight.

Suppose you stood on the sea-shore and saw a ship one or two miles off sail just between you and another ship ten or twenty miles off. If the near one *hid* the farther one it would be like an Eclipse. If the near one only appeared to be

side by side with the farther one it would be like a Conjunction.

There is still one more sight, which is also like an Eclipse in its nature. Sometimes one of the planets whose pathway lies nearer to the Sun than the Earth's pathway glides exactly between the Sun and ourselves.

This is just what the Moon does at an Eclipse of the Sun. But the planet is too far away from us to hide the Sun. We can only see a tiny dark body creeping across the Sun's face; and we call this a "TRANSIT," or a "passing over."

You will hear more about "Transits" in the next chapter.

QUESTIONS.

1. What is an Eclipse?

A hiding of light.

2. Tell me what causes an Eclipse of the Sun.

The round body of the Moon comes exactly between the Earth and the Sun, and hides the Sun from us.

3. Tell me what causes an Eclipse of the Moon.

The round body of the Earth comes exactly between Sun and Moon; and the Earth's shadow falling on the Moon makes her dark.

4. How far are the two alike?

In an Eclipse of the Sun, the Moon is be-

tween Sun and Earth. In an Eclipse of the Moon, the Earth is between Sun and Moon.

5. Do they seem just alike to us?

Not as seen from Earth. In an Eclipse of the Sun we see the Moon's solid body against the Sun. In an Eclipse of the Moon we see Earth's shadow crossing the Moon's face.

6. Does the Moon get nearer to the Sun than usual in an Eclipse of the Sun?

No nearer at all. She only passes *between* the Sun and Earth.

7. Are there any other eclipses?

Other planets with moons have eclipses in the same way.

8. Tell me another name for "moons."

Satellites.

9. What is a Conjunction of Planets?

When two planets happen to be seen near together in the sky we call that a Conjunction.

10. Are they really near together?

No nearer than usual. They only happen to lie in almost the same line of sight.

11. What is a Transit of a Planet?

Very much like an eclipse. One of the planets, nearer to the Sun than our Earth, gets exactly between the Sun and Earth.

12. Is the Sun's face hidden?

No; because the planet is too far away. We only see a small body crossing his face.

13. At what time is an Eclipse of the Sun?

Never at any other time than New Moon.

14. When do we have an Eclipse of the Moon?

Never at any other time than Full Moon.

15. What is a Total Eclipse of Sun or Moon?

When the whole face of the Sun or Moon is hidden.

16. What is a Partial Eclipse?

When only part of the face of Sun or Moon is hidden.

17. What is an Annular Eclipse of the Sun?

When a bright rim of the Sun is seen all round the dark body of the Moon.

CHAPTER XIII.

MERCURY AND VENUS.

Now let us take a flight through the Sun's great kingdom, paying a visit to one bright world after another on our way. We will start from near the Sun himself, stopping first to look at the two innermost of the Four Lesser Planets. We might name them The Sun's Body-Guard.

Mercury has a pathway round the Sun much more oval in its shape than our Earth's pathway. And the Sun is a good deal to one side of the exact middle of that oval. So Mercury, at one time of his year, is many millions of miles closer to the Sun than at another time.

You must remember that a Planet's Year means just the length of time that the Planet takes to go once round the Sun. Our Earth's yearly journey takes 365 days; but other worlds have years either longer or shorter. No two are exactly alike.

The length of Mercury's year is about 88 of our days, or three months of Earth-time. So four years of Mercury go to one of our years. If a little boy on Mercury had lived just as long as ten of our years, he would be forty years old!

When closest to the Sun, Mercury cannot easily be seen by us, he is so lost in the Sun's radiance. And although perhaps the brightest of the worlds, because so much the nearest, he often seems dim to us.

At his farthest off point from the Sun we have our best view of him, because he then stays longer above the horizon after the sunlight sinks away.

We never see Mercury high up in the sky, for when Mercury is high the Sun is up also; and when the Sun can be seen Mercury cannot be seen without a telescope.

The distance of Mercury from the Sun is commonly said to be about thirty-six millions of miles. That may be called his "middle-distance." He draws sometimes as near to the Sun as twenty-eight millions of miles, and goes as far off as forty-three millions of miles—a very great difference.

Even at his farthest Mercury has to endure an awful blaze of heat and glare; and at his nearest the most scorching mid-day ever known on the hottest parts of the Earth would be icy by comparison.

Mercury does not always go at the same pace through the sky. When near he travels faster, because the Sun's pull is stronger. When farther off he slackens his speed.

At his quickest he whirls onward at the rate of about *thirty-five miles each second!* Think of that! A railway train does pretty well if it gets over about thirty-five miles of ground each *hour*, and sixty or seventy miles an hour we count very fast travelling. But Mercury's speed is more than two thousand miles an hour. This quite puts our express trains to the blush.

It is impossible for us to see much of a planet so bathed in sunlight glory.

We do not know whether the axis of Mercury does or does not slant, like the Earth's axis. Nor are we at all sure how long it takes Mercury to spin upon his axis.

Wonderful as it sounds, Mercury has been weighed by man—and not only Mercury, but the Moon, and the Sun, and the other planets, and even some of the Stars. I cannot try, in a book such as this, to explain *how* the heavenly bodies are weighed from our little Earth. I can only tell you that it is really and truly done.

Mercury is a far heavier body than our Earth; not actually more heavy as a whole, because so much smaller, but heavier in *make*.

Do you see what this means? Iron is heavier than tin in its make. A large quantity of tin may weigh more than a small lump of iron; yet in actual make the iron is heavier. If Mercury were as big as our Earth, Mercury would be

very much the heavier of the two. Our Earth is less heavy in make than Mercury, but she comes next after Mercury. Other worlds are still lighter.

Mercury shines less brightly than Venus, as seen from the Earth. We have to allow for the greater distance of Mercury; but even then Venus seems to be more brilliant than one would expect, while Mercury is less brilliant.

Although the Sun pours his beams upon all things alike, those beams are not always received alike. Some worlds make more of the light which they have than do others, and they give out more shining in return. We see that even on the Earth. If a sheet of polished silver and a sheet of unpolished lead are held side by side in the sunlight, what a difference we find! The silver flashes brilliantly, while the lead shows only a dull sort of brightness.

Of these two worlds, so near to the Sun, Mercury, the nearer, is said to shine only like lead, while Venus, the farther, shines like silver.

Once in a while the tiny body of Mercury is seen to creep, as a little black dot, across the face of the Sun: though this is only visible in a telescope. Then we have a "Transit of Mercury." In the last chapter you were told what is meant by a Transit.

If Mercury were as near to us as our Moon

is, he would hide the Sun from us in his transit just as the Moon does in an eclipse—only more fully, because Mercury is bigger than our Moon.

In a Transit, as in an Eclipse, there is no real drawing together of Sun and Planet. Be very clear in your mind about this. Mercury glides *between* our Earth and the Sun, but he is just as far as usual from the Earth on one side and from the Sun on the other side.

If you are gazing at a church-tower a great many miles away, and a bird near at hand flies between, hiding for a moment that tower from you, the bird may be said to "eclipse" the tower. But he does not go nearer to the church. He only moves into the straight line between you and the tower.

And if, instead of this, a bird some distance off flies between — then you have a "transit." The more distant bird cannot hide the church-tower, but you see his little body pass across it, as a dark spot.

A transit of Mercury is not common. For though Mercury often passes between the Earth and the Sun he is not often *exactly* between. His oval pathway is not quite on the same level as the Earth's pathway. So he is usually a little too high or a little too low for us to see him against the Sun.

Leaving Mercury behind we come next to the pathway of the planet VENUS.

Mercury was a good deal smaller than our Earth; but Venus is almost the same size. Instead of being, like Mercury, only some thirty-six millions of miles away from the Sun, Venus is about sixty-five millions of miles off. She journeys round him at a rate of some twenty-two miles each second, and her year lasts about seven months and a half of Earth-time. In make she is not quite so solid and heavy as our Earth.

Venus in her journey round the Sun, as our Moon travels round the Earth, is now believed to turn on her axis so very slowly that the same side is always towards the Sun, and the other side is always turned away. If this really is so, one half of Venus has an endless day, and the other half an endless night.

The same state of things may possibly be also true of Mercury.

Both these worlds are believed to have air around them, and Venus seems to be enwrapped in thick clouds. This helps to explain the great brilliancy of Venus. Nothing lights up so well in sunshine as masses of cloud, though of course we on Earth more generally see the dark *under-sides* of clouds.

So far as we know, Venus is a lonely world.

She seems to have no little moon-friend to journey with her in the sky.

She has, however, a far more splendid Sun than ours—the very same Sun only much nearer, and bigger and more dazzling. She also has in her sky a very exquisite little shining Earth, far lovelier than Venus at her best ever appears to us. And I will tell you why.

Venus comes at times nearer to our Earth than any other world in all the sky, except our Moon. If the Moon is our little Sister-World Venus is our Next-Door Neighbor.

When the Earth happens to be on one side of the Sun and Venus on the other side the two then are widely parted. When both are on the same side of the Sun at once they are quite near—divided by only about twenty-six millions of miles.

Of course twenty-six millions of miles sound a good deal to you and me. We think so much of even one thousand miles on the Earth, and one million is a thousand thousand. But in talking of sky-distances twenty-six millions of miles are merely a matter of next-door neighbors!

Unfortunately, when Venus is at her nearest to us we cannot see her. She is then, like our Moon at New-Moon, between us and the Sun, so that her dark side is toward us, and her bright side is away from us.

This is a great pity, because she would be a lovely sight then, so near and brilliant. Our best sight of her is when she is away to one side, and then it is really only "Half-Venus" that we see. Even that half is the brightest of all heavenly bodies to us, after the Sun and Moon; but you can fancy how much more beautiful the whole would be.

We do see the whole of her when she gets right beyond the Sun; but then she is so very, very far away that she becomes much more small and dim.

However, when Venus is New-Venus to us—like the Moon being New-Moon—our Earth is Full-Earth to Venus. Then indeed our Earth must be a splendid sight, if only there were anybody on Venus to admire her!

When Venus comes between us and the Sun she is more commonly not *exactly* between. Now and then, however, instead of being a little higher or lower, she is just precisely between, and so we have a Transit of Venus. It is much the same as a Transit of Mercury. Only the round black dot is bigger, and can be seen more easily; sometimes even without a telescope.

Two transits of Venus come near together, within a few years. Then for more than a hundred years there is no transit; after which two more come again.

Venus can never see a transit or passing of our Earth over the Sun, because the pathway of the Earth lies outside the pathway of Venus. So our Earth can never pass between Venus and the Sun.

But Venus can see a transit of Mercury; and we on Earth can see transits of Mercury and Venus. And Mars doubtless can see transits of Mercury, Venus and Earth, though the Earth can never see a transit of Mars.

It is always an *outer* planet which sees an *inner* planet seem to pass across the Sun's face.

In all these cases, if the worlds were very near together—as near as our Moon is to the Earth—the Transits would be Eclipses.

QUESTIONS.

1. How far is Mercury from the Sun?

Sometimes nearer, sometimes farther; but, roughly, about 36 millions of miles.

2. How fast does Mercury journey?

At his fastest, about 35 miles each second.

3. How long is Mercury's year?

About 88 days, or three months, of Earth-time.

4. Can we see much of Mercury?

No; because it is too near to the Sun.

5. Is Mercury heavy or light in make?

Much heavier in make than our Earth is.

6. Which is brighter, Mercury or Venus?

Mercury gets most sunlight, but Venus reflects sunlight best.

7. What is a Transit of Mercury or Venus?

The planet passes exactly between Earth and Sun, and is seen against the Sun, crossing his face.

8. What distance is Venus from the Sun?

About 66 millions of miles.

9. How fast does Venus journey?

About 22 miles each second.

10. Why is Venus slower than Mercury?

Because Venus is farther off than Mercury from the Sun, and so the pull of the Sun is less.

11. How long is the year of Venus?

About seven months and a half of Earth-time.

12. Is any other planet in our sky brighter than Venus?

No planet or star—only the Sun and the Moon.

13. How near to us does Venus come?

At her nearest she is about 26 millions of miles off.

14. Is she very bright then?

Her bright side is turned away from us then, and we cannot see her at all.

15. When is our best view of Venus?

When we see her as really Half-Venus.

CHAPTER XIV.

THE PLANET MARS.

NEXT outside the pathway of Venus comes the pathway of another planet, named EARTH—this same globe on which we live. From it, as from a little boat on the great ocean, we look out upon other floating worlds, and upon the countless stars.

We can see the worlds and stars, but we cannot get to them. All of us are prisoners upon this little Earth-boat, during our earthly lives.

As a Planet our Earth is one of the smaller worlds. She is nearly 8,000 miles through, and about 25,000 miles round. She has a north pole and a south pole, and an equator. She has many continents and oceans, part of her surface being Land, and a larger part being Water.

The Earth spins on her axis once in twenty-four hours; and she travels round the Sun once in twelve months, going at a rate of about nineteen miles each second.

This is not so fast as Venus, and not nearly so fast as Mercury; yet it is seventy times faster than the speed of a cannon-ball.

Think of our whole big Earth, with all of us

on board, rushing wildly through the sky more than seventy times as fast as a cannon-ball rushes through the air. Only it is not "wildly;" the movements of the worlds, though very rapid, are calm and quiet.

Our Earth, like Mercury, goes sometimes a little faster and sometimes a little more slowly. When nearer to the Sun she travels faster, and when farther off from him she travels more slowly. But the differences in her speed are much less than in Mercury's, because her pathway is not so oval in shape, and so she is always more nearly at one distance from the Sun.

Outside Earth's pathway is that of MARS, the last of the Four Lesser Worlds.

His untwinkling red gleam is easily seen. Not always in the east or west, like that of Mercury and Venus; but, like all the outer planets, in different parts of the sky at different times.

Mars is much smaller than our Earth. He is only some 4,000 miles straight through. A big knitting-needle which might run just through him would have to be twice as long as one for the Moon, but only half as long as one for the Earth.

It takes Mars about twenty-four hours and a half to spin once on his axis; so days and nights are much the same in length there as with us. His axis, too, seems to lean over very much as

our Earth's axis does, and that would give Mars seasons a good deal like ours.

Only, as the year of Mars is almost as long as two Earthly years, his seasons would last much longer. Spring and summer, autumn and winter, would be each about five or six Earthly months in length.

The distance of Mars from the Sun is about 140 millions of miles.

So Venus is somewhere about twice as far off from the Sun as Mercury. The Earth is about three times as far as Mercury. Mars is more than four times as far as Mercury.

Mars is a very interesting little world. Not so brilliant or lovely as Venus, but really more easy for us to study and examine. Venus seems to be so covered with masses of white clouds that we can see very little of the planet itself; but Mars is not covered with clouds.

Mars never comes so near to us as Venus does. Only, unfortunately, Venus at her nearest cannot be seen at all, because her bright side is turned away from the Earth and towards the Sun. While Mars at his nearest, being *outside* the Earth, can be looked upon nicely, for the Sun then shines full upon that side of Mars which is towards us.

When we talk of "studying and examining" a world which never by any chance comes closer

than 35 millions of miles away, we have to be careful. It does not do to guess at things, or to be in a hurry to settle what cannot be truly known.

Even with the Moon we found that the biggest of telescopes cannot make her look very much less than one hundred miles away. But Mars is a great deal farther off than the Moon.

Just think of the difference! The 240 *thousands* of Moon-distance are changed into 35 *millions* of miles for the distance of Mars. And the most powerful telescope cannot bring down those 35 millions of miles to less than about 35 thousands of miles.

So when people talk about Mars, and about what may be seen on Mars, remember this—that at the very best *we can only see Mars as we should see a world* 35 *thousands of miles away!*

On the Earth even a hundred miles seems a long distance. From the top of a mountain one can see to a hundred miles no doubt, in clear weather; but very little can be made out at such a distance. Yet a hundred miles would be only a small piece of one country. It takes ten hundreds to make a thousand, and a thousand miles off seems to us very far indeed.

Nobody on the Earth can ever be farther from us than about 8,000 or about 12,000 miles off, that is, through the middle of the Earth 8,000

miles, or reckoning round the outside rather over 12,000. You know how distant Australia seems from us.

But Mars at his nearest, and looked at through the largest of telescopes, is still only seen as a world *three times farther away* than the very farthest off country upon this whole Earth from you or me.

Of course it is very wonderful that a planet thirty-five millions of miles away can be actually seen through a telescope as if it were only thirty-five thousands of miles away. Still, at the best, thirty-five thousands of miles is a pretty good distance.

Although we cannot find out half or a quarter of what we want to know about Mars, still we do know a good deal. The big telescopes tell us much, and another instrument, called a "spectroscope," tells us yet more. But in this small book I cannot even try to explain to you what a "spectroscope" is.*

We know that Mars has some sort of air, perhaps rather like our Earth air, only more thin. We know that water floats in that air, as water floats unseen in our air.

As for climates, one might expect Mars to be terribly cold at such a distance from the Sun. He cannot have half the quantity of light or

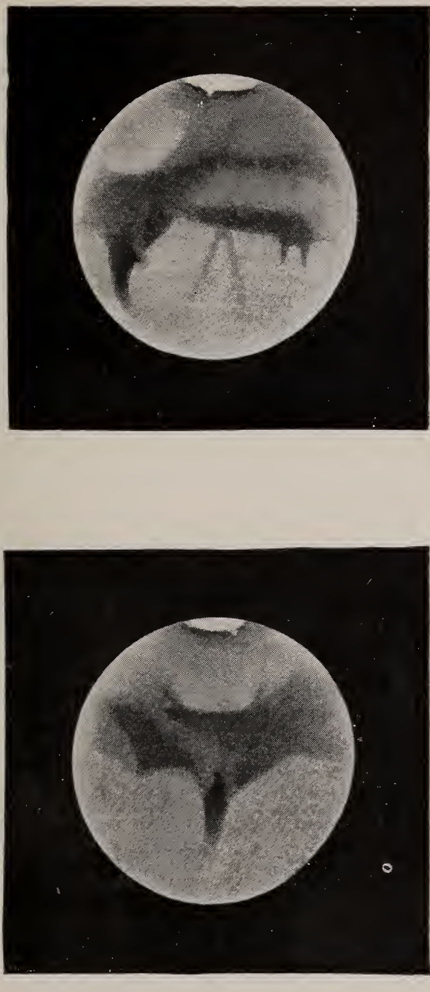
* See "Sun, Moon, and Stars," page 307.

heat that we have. Yet, somehow, there seem to be signs that Mars is not a very much colder world than our Earth is.

At the north pole and the south pole of Mars tiny white caps, or patches, are seen ; and these are most likely made of ice and snow. We on the Earth have always ice and snow at our two poles ; and people on another world, a long way off, might perhaps see our polar ice and snow as white caps, or patches.

Sometimes clouds are seen to flit across Mars, white clouds, like the white clouds which cover Venus. This only means that they are white outside, on the *upper* surface, where the Sun shines. They may be gray below, like so many of our gray Earth clouds, though we also often see clouds white and shining in sunlight. And when a man gets up a high mountain above the clouds, and looks down upon them, he sees their upper surface, white as snow and beautifully bright.

Mars commonly looks red, when seen without a telescope. If seen through a telescope, greenish and purplish patches are found. It is very likely that the one color shows land and the other water. Since Mars has water-vapor in the air, and probably snow and ice at the poles, he is pretty sure to have oceans also. But the continents and oceans of Mars are differently shaped



Mars. August 22 *and* 29, 1892.

from ours. There seems to be more of land and less of sea.

Thus in a good many ways Mars is not so very unlike our Earth, his next-door neighbor. Day and night seem to be much the same in both worlds, also summer and winter. We think, too, that we find there air and water, snow and ice, lands and seas, changes of weather and differences of climate, more or less like those of the Earth.

But if you ask me whether animals and men and women and children live on Mars, I can only say that *nobody knows*. It may not be impossible, so far as we are able to judge. We feel pretty sure that no living creatures such as we ever see on the Earth could exist on the Moon or the Sun. And with Mercury, if not also with Venus, we are hardly less sure, when we think of the intense glare and awful heat in which those two worlds travel.

With Mars there is some difference. Knowing the little we do know, it certainly seems a thing by no means out of the question that living creatures *might* find a home on Mars--creatures not utterly unlike those upon the Earth. But we cannot for a moment say that they do.

One difference between Mars and the Earth which would make life there very unlike life on the Earth is its small size.

On Mars, as on the Earth, there is the "pull" of attraction. "Downward" all round the planet is towards the centre of Mars, and "upward" all round is towards the sky of Mars; and everything in Mars is heavy towards the centre of the planet.

But the *pull* there is much less than here, because Mars is so small; and the less pull means less weight. A lump of iron which weighs ten pounds on the Earth would weigh less than five pounds on Mars. If a man went to Mars he would be as light there as a boy on the Earth; and if a boy went there he would weigh as little as a baby on the Earth.

The two moons which travel with Mars are very tiny, perhaps only about eight or ten miles through.

Between the planet Mars and the planet Jupiter lies an enormous gap of millions of miles empty of all large worlds, even of worlds as big as our Moon.

Somewhere about the middle of that vast gap, about half-way between Mars and Jupiter, is the belt of PLANETOIDS.

Less than four hundred of them are as yet actually known to us; but perhaps thousands of them may be there. Each of these tiny planets has its own pathway round the Sun, and their pathways do not keep nearly to the level of

the Earth's pathway, like those of the bigger worlds.

Vesta, the largest of them all, is perhaps over three hundred miles through, and three others come rather near Vesta in size. The greater number are under one hundred miles through; some being mere balls, about the size of Mars' moons.

QUESTIONS.

1. Which is the next planet outside Venus?

The Earth on which we live.

2. How far is the Earth from the Sun?

About 92 millions of miles.

3. How fast does our Earth travel?

About 19 miles each second.

4. How long is the Earth's year?

About 365 days, or 12 months.

5. Which is the next planet outside the Earth?

Mars.

6. What is the diameter of Mars?

About 4,000 miles, or half that of our Earth.

7. How far is Mars from the Sun?

About 140 millions of miles.

8. How long is Mars' year?

Nearly twice as long as our year.

9. Does Mars spin on his axis?

He is believed to do so, in twenty-four hours and a half.

10. How near does Mars come to us?

Never closer than 35 millions of miles off.

11. But how much nearer does the most powerful telescope seem to bring Mars?

Perhaps to about 35 thousands of miles off.

12. Are air and water found on Mars?

Some kind of air, and water also, and ice and snow.

13. Are there oceans on Mars?

There are patches of color which may be continents and oceans.

14. Where are ice and snow perhaps seen on Mars?

White caps are seen at the two poles.

15. Is Mars inhabited?

Nobody can tell. It does not seem to be quite impossible, so far as we understand what Mars is like.

16. Which planet comes next after Mars?

Hundreds of Planetoids come next.

17. Are they close to Mars?

No; there is a great space between Mars' pathway and Jupiter's pathway; and the Ring of Planetoids lies somewhere about the middle of that great space.

18. What is the name of the biggest Planetoid?

Vesta.

CHAPTER XV.

THE PLANET JUPITER.

Now we pass on to Jupiter, chief in size of all the worlds in the kingdom of the Sun.

The four inner planets are all small together. The four outer planets are all large together, Jupiter and Saturn being the twin giants of the Solar System.

You now know that the distance of Mercury from the Sun is about 35 millions of miles, and that the distance of Mars is about *four* times that of Mercury. But the distance of Jupiter from the Sun is nearly *fourteen* times that of Mercury. Think what an enormous gap this means between the pathway of Mars and the pathway of Jupiter.

And, distant as Jupiter is from the Sun, he is quite as far from his next neighbor on the other side, Saturn. So Jupiter lies just about half-way between the Sun and Saturn.

Yet Saturn is nearer to Jupiter than to his other neighbor, Uranus. The gap between the pathway of Saturn and the pathway of Uranus is *twice* as broad as the gap between Jupiter and Saturn.

Outside Uranus stretches another vast empty space: and then we get to the last known planet, far-away Neptune!

Jupiter whirls with such speed upon his axis, that it takes him less than ten hours to spin once round. A day of only five hours, and a night of only five hours! How should we like that?

But with the short day he has a very long year. Jupiter gets once round the Sun in twelve of our earthly years. So a man who on Earth is nearly forty years old would on Jupiter be just over three years old: and an old Earthly gentleman of seventy would there be under the age of six. Our little boys and girls would hardly like only one birthday in twelve years.

We have seen how, with greater distance from the Sun, each planet goes more and more slowly, as the Sun's pulling becomes weaker. Jupiter rolls through the skies at a rate of only about eight miles each second.

A beautiful world is Jupiter, looked upon from the Earth: the brightest in our sky after Venus. No other planet, except Venus, and no Star in the heavens can outshine Jupiter. This is because of two things—his great size and his nearness to us. Not nearness compared with that of the smaller worlds, but nearness com-

pared with that of Saturn and Uranus and Neptune.

Saturn, though almost as big as Jupiter, is very much farther off. And while Jupiter can hardly be so bright actually as Mars, because very much farther from the Sun, yet his huge size makes him greatly outshine Mars, which is so much nearer to us than he is.

Seen through a pretty good telescope, Jupiter grows into a broad, soft, moon-like world, very flat at the north and south poles, with colored bands round him, on and near his equator. Four small bright moons are also to be noticed. Sometimes all four can be seen at once; sometimes one or two are hidden behind him, or the shadow of one creeps like a black dot over his face. The fifth little moon, found lately, can seldom be seen.

Through a bigger telescope, Jupiter shows exquisite colors—rich reds, and browns, and greens, and purples. But these markings do not mean continents and oceans, as they perhaps mean on Mars. They are believed to belong to a very stormy Cloudland.

Jupiter seems to be wrapped in thick masses of clouds; and these clouds are ever on the move, always changing their shapes. It may be that we now and then get a tiny glimpse through them of the more solid world within, but this we

cannot be sure of. It *may* be that the clouds never part so far as to let us see through. It *may* be that there is nothing solid within at all.

Anyhow, the solid part is very much smaller than the size of the Jupiter we see. For, like other planets, Jupiter has been weighed, and he is found to be very light in make. He is not nearly so heavy as one would expect with a globe of that size.

The inner part may or may not be solid; some say it is most likely *not*. At any rate, it is enfolded by an enormous thickness of heated and tempestuous clouds.

When you look up into the sky from the Earth you see the clouds moving and changing their shapes slowly. But if you could go quite near you would find their changes to be really very quick.

And just so—only very much more so—at the vast distance of Jupiter we see movements which to us seem tiny and slow, yet which we believe to mean there, on the spot, the wildest rushings of heated clouds hither and thither. No storms on the Earth can be spoken of in the same breath with the terrific storms on Jupiter.

And the question is—what brings this about? Our earthly tempests are caused by the heat of the Sun, but the Sun is so very far from Jupiter

and yet the storms there are much more violent than any here.

Do you remember being told that once upon a time, long, long ago, our Earth, now so cold and quiet a globe, was most likely a dazzling little Sun, and that she slowly cooled down from a Sun to a world?

When she was a Sun she was fiercely hot and glowing gases played over her; and instead of solid ground and liquid seas there were only raging vapors, bright with their own heat. The Earth was larger then than now, for gases take up much more room than water and rocks and earth.

Between those days and these our Earth must have passed through a *half-way* stage.

Suppose you have a lump of ice, and you wish to turn it into hot steam—how can you do it? Of course you must heat the ice, and then it will melt—not into steam, but into water. And when you have the water you can heat that again till it boils and goes off in steam—or, as we say, "it boils away."

Again, if you had steam and wished to turn it into ice, it would have to go through being water between the steam-state and the ice-state.

So the water is a kind of half-way stage between ice and steam—between great cold and great heat.

No doubt, our Earth, as she cooled, passed through a "half-way stage" too. She did not all at once become firm and cool. First she was a bright Sun, made of glowing gases. Then she was a half-sun, half-world: no longer shining, yet very hot indeed; no longer made of gases, but by no means solid. Then lastly she cooled down, as we now see her.

These are, we suppose, three chief parts in the story or life of a heavenly body. Our Sun is in the early part—made of gases, exceedingly hot and bright. Our Earth is in the later part, cold and firm, and not shining!

But Jupiter seems to be still in the middle part, in the half-way stage. He is very, very hot, yet not so hot as to give forth light of his own, for he shines by the Sun's light. He is not any longer a great mass of gases, yet he seems to be very far from being solid and firm. The clouds which cover Jupiter, though not like the fiercely-glowing Sun-clouds, are yet very unlike our cool Earthly mists, and perhaps they may be at least as hot as the steam which pours from a boiling kettle.

So the furious hurricanes on Jupiter are brought about, partly, at all events, by Jupiter's own heat, and not by the Sun's power alone.

On the whole, we can hardly look upon Jupiter

as a nice and fit place for either animals or men to live in. That does not mean that he can never become nice and fit. Our Earth was a very, very long time being made ready to serve as a home for men. Perhaps Jupiter is being made ready also for some such use. As he is so large he cannot cool down nearly so fast as our Earth.

Jupiter's moons all shine as our moon shines, by borrowed sunlight.

The smallest of his four chief moons—which can easily be seen from the Earth—is about the same size as our Moon, and the biggest is larger than Mercury.

QUESTIONS.

1. Which is the largest of the planets?

Jupiter.

2. How far is Jupiter from the Sun?

Nearly fourteen times as far as Mercury is.

3. How much farther still is Saturn?

Saturn is as far from Jupiter as Jupiter is from the Sun. So the distance of Saturn is twice the distance of Jupiter.

4. How far is Uranus?

Uranus is twice as far from Saturn as Saturn is from Jupiter.

5. Does Jupiter spin on his axis?

Yes, in less than ten of our hours.

6. How long is Jupiter's year?

About twelve of our years in length.

7. How fast does Jupiter travel?

About eight miles each second.

8. Does Jupiter shine in our sky as brightly as Venus?

No, but he is the next brightest planet in our sky after Venus.

9. How many moons has Jupiter?

Five moons, four of which can be seen easily. The fifth was only discovered a little while ago.

10. Has Jupiter any markings?

He has bands and beautiful coloring when seen in a telescope.

11. Is Jupiter light or heavy?

Very light in make; so light that he is thought to be far from solid, and to be wrapped in very thick masses of clouds.

12. Is Jupiter a cooled world like the Earth?

Jupiter seems to be only a half-cooled world.

13. Is he hot enough to shine?

Jupiter is too cool to shine with his own light; but he seems to be in a very heated and stormy state.

14. How do Jupiter's moons shine?

Like Jupiter himself, by reflected sunlight.

CHAPTER XVI.

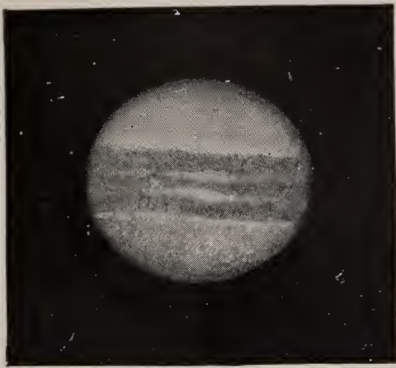
SATURN, URANUS AND NEPTUNE.

SATURN is only a little smaller than Jupiter, and very light indeed in weight. Not at all like our firm and solid Earth. He actually weighs *less than water*; which means that if we could make a huge globe, all of water, the same size as Saturn, this water-globe would be heavier than Saturn.

This does not look as if Saturn were a very cold or solid globe, does it? A solid globe would surely weigh a great deal more than water.

Saturn whirls round on his axis once in ten hours, like Jupiter. But his year is much longer than Jupiter's year: partly because he is twice as far away from the Sun, which means a very much longer journey, and partly because at that distance he goes much more slowly. So one year of Saturn is as long as nearly thirty of our years. A man who on the Earth is seventy would on Saturn be only a little over two years old.

In shape Saturn is very flat at the north and south poles, the same as Jupiter. Also on Saturn can be seen dimly-colored bands and mark-



Jupiter.

Saturn.

ings. But these are much less clear than on Jupiter.

However Saturn has something which Jupiter has not: Saturn has his Rings.

Until telescopes were made these rings could not be seen; and when first noticed they were a great puzzle.

They lie round the vast globe of Saturn, one outside another, stretching far away up into Saturn's sky. If you were on Saturn, standing just underneath the rings, the most you could see would be a narrow rim, or line, far over your head. But if you walked some distance off, in the right direction, you would have a lovely view of the rings, as wide bands, one above another, shining in the sunlight.

For the rings of Saturn, like the eight moons of Saturn, have no brightness of their own. They shine when the Sun shines on them.

And the Sun, as seen from Saturn, is very far off, and very small, compared with the big round orb which we see in our sky. Those rings and moons must shine but dimly, compared with the shining of our bright Moon.

Yet, since *we* can see them and find them lovely, even across all this great width of distance, they must surely be beautiful seen from Saturn.

But to talk of anybody walking about on Sa-

turn, to gaze at the rings, is really only nonsense.

For Saturn, like Jupiter, seems to be only a half-cooled world—in fact, even less cooled, less solid, than Jupiter. Nobody could very well walk across great masses of heated and seething clouds in a perpetual turmoil of storms.

I think we may safely say that Saturn at present would not offer a very comfortable home, at all events, for any such living creatures as we know upon the Earth.

URANUS, the next planet outside Saturn, was seen first, rather more than a hundred years ago, by a famous English astronomer named Herschel.

It takes Uranus 84 Earthly years to travel once round the Sun, at a rate of about four miles each second. So a man of 84 on Earth would be only just one year old on Uranus.

Four moons journey with Uranus; and some glimpses have been caught of very faint band-markings on the planet, like those of Jupiter and Saturn. Little can be seen or known of worlds so far away: but it is most likely that Uranus and Neptune are both more or less in the half-hot state of the two big twin planets. Both Uranus and Neptune are light in make. weighing about the same as water.

NEPTUNE, the very farthest off world of all

known to us, journeys round the Sun at a distance of about 2,800 millions of miles, or *eighty times as far off as Mercury*. It is not very easy to see in our minds what this means. We must climb up to the thought, step by step.

Think first of a rope one hundred miles long. Perhaps you have gone in the train from New York to Philadelphia. A rope one hundred miles in length would reach all the way and ten miles farther.

Next, think of ten such ropes joined together, making a single rope one thousand miles long.

Then think of twenty-five of those ropes joined into one rope, 25,000 miles long.

This rope would just about go round the Earth, lying on the equator like a girdle.

It would take *ten* such Earth-girdles to reach straight from the Earth to the Moon.

But we have to get the thought of one million miles. Well, you would need about *forty* Earth-girdles—forty ropes, each one being 25,000 miles long—to make a rope one million miles in length.

And when we get so far it is still only one million. Mercury is thirty-five millions of miles away from the Sun.

So, for the distance of Mercury, you would need — first, forty Earth-girdles joined into a

one-million mile rope, and then thirty-five of those million-mile ropes, to stretch all the great way from the Sun to his nearest planet, Mercury.

When you have in mind that enormously long rope, reaching from the Sun to Mercury, the rest is easier.

Two such ropes would about reach from the Sun to Venus. *Three* such ropes would about reach from the Sun to our Earth. *Four* such ropes would about reach from the Sun to Mars.

But to reach from the Sun to Jupiter no less than *fourteen* such ropes would be needed.

And to reach all the way to the distant Neptune, from the Sun, *eighty* such ropes would be needed!

There indeed we find ourselves in a region of dimness and fearful cold. We can hardly fancy any human beings like ourselves living at so enormous a distance from the storehouse of light and heat.

Our bright and glorious Sun, seen from Neptune, looks no larger than the planet Venus looks to us here. You and I on Earth have *nine hundred times* as much light, and *nine hundred times* as much heat, from the Sun, as a man on Neptune would have. Of course, if Neptune is only partly cooled, there may be plenty of heat from the planet itself.

However, you must not think that the Sun even there looks only like Venus or Jupiter in our sky. Though small in size, he shines dazzlingly still. But after what we enjoy on Earth Neptune would indeed to us be a world of darkness.

Travelling at the rate of three miles in a second, Neptune gets once round the Sun in 165 of our years.

This planet was not discovered by accident, but through careful searching. Some day you will read with interest the story of how and why it was hunted for in the sky—and found.*

Speaking of the distance of one planet from another we mean usually their *nearest* distances, when they are both on one side of the Sun together. When they are on opposite sides of the Sun they are very much farther apart.

The moons belonging to these planets are really like planets, or worlds, travelling with the bigger worlds. Some of them are not so very little, either. Mars' moons are most tiny; but one of Jupiter's moons, as you heard, is larger than Mercury. Mercury, however, being the nearest planet to the Sun, is a much more important world than a far-off moon of Jupiter can be.

Each moon, whether of Jupiter, of Saturn,

* See "Sun, Moon and Stars," pp. 227–234.

or of any other planet, travels, like our Moon, in a pathway of its own round the Sun. And as it goes it curves backwards and forwards, so as to face in turn each side of the large world with which it journeys.

The pull of a great body like Jupiter is very strong; and the moons in consequence travel very fast round Jupiter—the nearest going most rapidly, the farthest off most slowly. It is the same again with Saturn's eight moons.

QUESTIONS.

1. What is the size of Saturn?

Almost as large as Jupiter.

2. Does Saturn spin on his axis?

Yes, in about ten hours, like Jupiter.

3. How long is Saturn's year?

Nearly thirty of our years.

4. Is Saturn like Jupiter in make?

Saturn is very light, even lighter than Jupiter; not so heavy as water. Saturn, too, has faint bands of color.

5. What is Saturn's state believed to be?

Half-cooled, and very stormy, with great masses of cloud.

6. How many moons has Saturn?

Eight moons, and also three rings.

7. How do the rings shine?

Like the moons, on one side, by reflected sunlight.

8. When was Uranus discovered?

About one hundred years ago.

9. By whom?

By Herschel.

10. How long is the year of Uranus?

Eighty-four of our years.

11. How many moons has Uranus?

Four moons are known.

12. What size are these two outer planets, Uranus and Neptune?

Much larger than Venus or the Earth, much smaller than Jupiter or Saturn.

13. How far is Neptune from the Sun?

Eighty times the distance of Mercury, or twenty-eight hundred millions of miles.

14. How fast does Neptune travel?

Some three miles each second.

15. What is the length of Neptune's year?

About one hundred and sixty-five of our years.

16. How many moons has Neptune?

Only one has been seen.

17. Are Uranus and Neptune light or heavy in make?

About as light in make as water.

CHAPTER XVII.

LONG-TAILED COMETS.

A good deal has been said about empty gaps in the sky between and around the pathways of the worlds. But those gaps are at least not always quite empty.

Comets, with long bright tails, flash through the darkness by hundreds, perhaps thousands. Meteors travel in vast swarms, by millions of millions. Each comet gives forth a radiant shining, and each little meteor is bright in the sunlight. I am going to tell you about Comets first, and then about Meteors.

The word "comet" means "a hairy star."

But comets are not stars really, though they have often been mistaken for stars, especially when first seen without any tail.

There may be any number of comets as far away as the stars, millions of them in each direction. But those we cannot possibly see. We only see such comets as belong to our Sun and travel about in his kingdom, or else those which come to pay him a visit from far away.

No comet that is outside the Solar System can be visible to us on the Earth. The distance

becomes too great. For the light of a comet is not like the light of a star, and it cannot reach through billions of miles, as the light of a star can.

Once in a while a splendid comet makes its appearance, with a tail reaching half across our sky. But this is not at all common. Most of those seen are small and faint, and the greater number can only be seen at all in telescopes.

Almost every year some fresh ones are found in the sky, and hardly a day passes in which at least one may not be noticed, in some part of the heavens, with a good telescope.

Each comet, like each world, has its own pathway in the sky round the Sun. But a comet-pathway is much more oval in shape than a planet-pathway. Sometimes it is a very long and very narrow oval indeed, with the Sun almost close to one end of the long oval.

To get round such a pathway as this takes a good while. At one part the comet gets quite near to the Sun, and then rushes at a tremendous speed. After which he wanders far away from the Sun, and creeps along more and more slowly.

There are comets belonging to the Solar System which draw closer to the Sun than Mercury and go farther away than Neptune.

Comet-pathways do not keep to the level of

the chief planet-pathways. They slope about in all manner of ways, like the paths of the little Planetoids.

Very many comets belong to the Sun's kingdom. They journey round and round the Sun, and appear again and again from time to time. Some take only a few years for their journey, while others come back only once in the life of a man; and others again may be hundreds of years absent.

And some comets never return. They do not belong to our Sun, but only pay him a single visit. These are strangers to our kingdom of worlds, travelling from the kingdom of some other far-off sun, perhaps one of the twinkling stars in our sky.

A stranger comet comes, like other comets, slowly from the distance, quickening his speed day by day as he gets nearer to the Sun. Then he rushes at a mad rate round the Sun and flies off in a new direction, to quite another part of the heavens.

What wonderful stories these bright visitors might tell us, if they could speak, of the skies from which they arrive!

A comet is made of three parts: the *nucleus*, or the thickest portion of the head; the *coma*, or the bright fog round the nucleus; and the *train* or *tail*.

Sometimes there is no nucleus, and sometimes there is no tail; but there is always a coma—a soft hazy cloud of light, perhaps small enough to look like a dim star at first.

But a comet watched from the Earth can never be so far off as the stars. Even the very largest comets are seldom to be seen farther away than Jupiter.

There are comets of all sizes, from the huge to the tiny. Perhaps one would find as much difference between comets in the sky as between a whale and a minnow in water.

Under a certain size they are hidden from us; but tinier comets than we can see may float in the sky by myriads.

Of those which we can see, the thickest and heaviest part of the whole—the "nucleus"—may be only about fifty or a hundred miles through, or it may be some thousands of miles. The coma, or bright fog surrounding this thickest part of the comet, is generally as much as ten thousand miles across; and sometimes it is a hundred thousand miles. As for the bright train, it is, when fully formed, seldom less than ten millions of miles long, and sometimes it is a hundred millions of miles. Such a tail as this would reach the whole way from our Earth to the Sun.

Yet a comet is not heavy. Its make is most

wonderfully light; far more so than the very lightest world in the Sun's kingdom. Saturn is not so solid or so heavy as water; but a comet really almost seems to be less solid and heavy than a mist.

Very faint stars can be seen shining through thousands of miles of comet-thickness; while it does not take much of an earth-mist to hide the light of even the brightest star.

Not long ago people were much frightened at comets. If a big one appeared in the sky it was thought to be a sign of something dreadful about to happen. Nobody then had any idea what immense numbers of comets are always in the sky.

It was feared that, if a comet should run against our Earth, the whole world would be destroyed. Nobody knew how very light and delicate in its make a comet is.

If such a thing ever did happen, which is most unlikely, one cannot say that no harm would be done; but certainly our Earth would not be destroyed.

These comets seem to shine partly in the sunlight, and partly by their own brightness.

You must not think that a comet always has a tail. More often, when one is first seen in the distance, it is only as a little hazy patch, or like a dim star, with no train of light at all.

But as it comes hastening out of cold and

darkness into the warmth and glare of the Sun great changes take place in its shape.

The nucleus very often gets a little smaller; and why this should be I cannot tell you. But the coma gets larger, and takes to throwing out bright jets. Then the tail begins to grow; and day by day it becomes larger and larger.

A comet drawing nearer to the Sun travels head-foremost, with the tail following after the head. This is only what one would expect.

But as the comet swings round the Sun with a mighty rush its tail is sent round also in a great outward sweep, pointing all the time away from the Sun.

Lastly, as the comet on the other side of its pathway goes away from the Sun, its tail travels first, end-foremost, and the head follows after the tail.

So the head of a comet always points towards the Sun, and the tail of a comet always points away from the Sun.

We know little as to the true nature of comets. They are, however, believed to be made partly of shining gases, and partly perhaps of small masses or lumps of more solid substance—in short, of little meteors.

Biela's Comet was once a comet belonging to the Sun's kingdom; but its story is rather curious. In 1846 it broke into two separate com-

ets. These two kept company for a while, and then parted. One went ahead, and one dropped behind. After this both vanished, and in their stead our Earth in her journeying came across a shower of meteors. So perhaps the meteors are the remains of those two comets—the broken up bits, if one may so speak.

The Great Comet of 1882 was often to be seen in full daylight. When passing away, after its rapid whirl round the Sun, it could be perceived in telescopes at a distance greater than that of Jupiter—a very unusual thing.

In the picture of a Sun-Eclipse you will notice a tiny comet quite near the Sun. This little comet had been hidden by the Sun's glare and nobody knew it to be there at all. But when the moon glided between, hiding the Sun's great brightness, and a photograph was taken — then the tiny comet had its picture taken also, side by side with the dark body of the Moon and the light edge of the Sun, with the fiery sea and sharp mountains.

QUESTIONS.

1. What does the word "comet" mean?

It means "a hairy star."

2. What is a comet like?

A star-like body, with a hazy kind of fog round it, and a long tail.

3. Do comets always have tails?

No; the tail generally appears when the comet comes near to the Sun.

4. Tell me the three parts of a comet.

The Nucleus, or thickest part; the Coma, or hazy part round the Nucleus; and the long Tail or Train.

5. Which of these is always found in a comet?

Only the coma. The nucleus and tail may be wanting.

6. What shape is a comet's pathway?

A long oval: sometimes very long and narrow indeed, with the Sun close to one end of it.

7. How long is a comet's year?

All lengths, from three or four of our years up to hundreds of our years.

8. Do all comets belong to the Solar System?

No; only a certain number seem to do so.

9. Where do others come from?

They seem to come from far-distant stars, paying one visit to our Sun, and then going off, never to return.

10. How does a comet carry its tail?

Always pointing away from the Sun.

11. Which goes first, head or tail?

When a comet is coming towards the Sun its head journeys first. But when a comet is going away from the Sun, its tail journeys first.

12. What is a comet made of?

It is believed to be made partly of gases, and perhaps partly of meteors.

13. Is a comet heavy, or light?

Very light indeed, compared with its great size.

CHAPTER XVIII.

LITTLE METEORS.

METEORS are the very smallest bodies of which we know, that float and rush about in the sky.

Besides being the smallest they are also the most abundant. Their numbers are not only past counting, but past our power to imagine.

We cannot see them as they speed hither and thither through the skies, travelling either alone or in tens of millions.

Each one indeed gives forth its tiny light, borrowed from the Sun. But those dim gleams are far too weak to reach us here on Earth. The only time when they can be seen by us is when they come by accident into our air.

Then indeed we do see them—not by the gentle shining which they catch from the Sun, but by one brilliant flash of light as they are destroyed.

It is the rush through our thick air which destroys the meteors. The air always tries to hold back anything moving fast through it.

A meteor far away in the sky is a hard and cold little body—very cold indeed, out in the

terrible cold of Space. It has no light of its own to give forth.

And in the sky a meteor goes very fast, rushing round the Sun. When it first gets into our air it keeps up that great speed. The air tries to hold it back; and the rubbing of the air against it heats the outside of the little meteor so intensely that it glows with bright light.

It becomes in fact "white-hot." The outside melts and pours away in a stream of shining dust, which to us looks like a tail of light. The dust soon cools, and drops gently down upon the ground.

Before the meteor has rushed twenty or thirty miles it is generally done for. All of it has gone off in bright dust, and nothing is left of the tiny heavenly body except that dust.

This is what you see when you look at a "shooting star" after dark. Of course you have seen shooting stars very often. If not, you should begin to look out for them as soon as possible.

A shooting star is no star at all, really. It is only a little meteor, or meteorite, which has travelled for ages in the skies, and which has at last happened to come too near to our Earth. The strong pull of the Earth's attraction has dragged it into the air, and so it has perished.

Hundreds and thousands of meteors are ever

dropping earthward. If it were not for our soft protecting air we should be under a regular cannonade from the sky; but happily most of the cannon-balls are used up long before they can reach the ground.

On the Moon, where there is no protecting air, one would have to undergo a fearful battering.

Now and again a meteor is large enough not to be *all* destroyed in its rush downwards. A good part is melted, and runs away as a little tail of brightness, but both speed and heat grow less before the whole is gone.

So then part falls to the ground as a solid stone, or as a lump of iron and other metals. We call the fallen lump an "aerolite" or a "meteorite," or a "meteoric stone." But it is commonly just a meteor which has come to us out of the sky.

Some very large aerolites have been known to burst in the air with a great noise, and to scatter hot stones over the land below. This sort of thing happens very seldom.

There are wonderful Rings of Meteors journeying round the Sun—enormous companies of millions upon millions of little dark cold bodies, lighted up by the Sun's rays.

Every August and November our Earth in her journeying touches one such Ring. In those

months a great many more "shooting stars" may be seen in the sky than at other times of the year. So, when you want to see shooting stars, remember that the best times are August and November. If then you watch the sky steadily after dark for half an hour you will hardly fail to see at least two or three.

About once in every thirty-three years our Earth plunges into the very thick of one of these Meteor-Rings. And then indeed we may have a splendid sight!

Tens of thousands of meteors can be seen flashing through the air, each with its little train of light behind. Fast as they appear and vanish tens of thousands more follow; and for hours this goes on.

Yet even then the number of meteors which can be seen is as nothing compared with the vast hosts which cannot be seen because they do not come into our air.

Sometimes comets and meteor-rings are found together, journeying in company. That is to say, the comet journeys with the meteors, in the same ring or pathway round the Sun. This really seems to show that the one may belong to the other.

I have told you already that comets, or at least comets' heads, are believed to be made partly of little meteors. If things are so, one

would not be surprised to find a very close tie between comets and rings of meteors.

You will remember Biela's Comet, spoken of in the last chapter, which some people think has actually broken up into separate meteors.

It is thought very likely that the wonderful Rings of Saturn are entirely made of meteors. Not of bright dying meteors, as we see them in our air, but of countless millions of tiny hard bodies, all whirling together round and round the huge planet, and giving forth such light as they can borrow from the Sun.

Sometimes on the Earth a faint light is seen, of a sugar-loaf shape, in the eastern sky, before dawn, or in the western sky after sunset. It is called the Zodiacal Light, and it plainly has to do with the Sun. It is always seen very near to the Sun, never anywhere else.

We know little about this curious light, but it too *may* be caused by the shining of enormous numbers of meteors, all whirling round the Sun. No doubt countless multitudes are ever dropping down upon his fiery surface.

Each little meteor that journeys round the Sun shines, like the worlds, on one side only—that side which is towards the Sun.

QUESTIONS.

1. What are Meteors?

The smallest heavenly bodies known to us.

2. How many meteors are there?

Immense multitudes in the sky, beyond our power even to imagine.

3. How do meteors shine when journeying in the sky?

They shine by borrowed sunlight.

4. Does a meteor shine all round?

No; only on that side which is towards the Sun.

5. Do we see meteors by means of that borrowed sunlight?

No; we only see them when they rush into our air.

6. What makes them visible to us then?

They are so much heated by the rubbing of the air as to shine brightly for a moment with their own light.

7. What becomes of such meteors?

The outside is melted and streams behind as shining dust.

8. Does any part of them reach the ground?

Generally they are destroyed in their rush through the air, and only the dust drops downwards.

9. Are they always quite destroyed?

Sometimes a part escapes, if the meteor is rather large, and then a solid lump of rock or metal comes to the ground.

10. What is such a lump called?

A Meteorite, or an Aerolite, or a Meteoric Stone.

11. What is it really?

Part of a meteor from the sky.

12. What do we call a meteor seen only by its last flash?

Either a "meteor" or "a shooting star."

13. When are shooting-stars most common?

In August and November.

14. Why?

Because our Earth then touches meteor rings, and so a great many come into our air.

15. When does our Earth plunge deep into a meteor-ring?

About once in every thirty-three years.

16. What is seen then?

A most wonderful display of tens of thousands of meteors.

CHAPTER XIX.

THE SUN'S KINGDOM.

By this time you have a pretty fair idea of what is meant by "The Solar System."

First you had to think about our Earth's pathway in the sky, and then about other pathways, nearer and farther, like vast oval hoops lying within and without the Earth's pathways. Lying, all of them, very nearly on the same level.

But the Planetoids' paths do not keep at all nearly to that level, rings of Meteors slope about in different ways, and Comets come and go, with no known rule, from any part of the heavens.

When we talk of a "level" in the sky—a "plane" is the better word—you must not think of a solid flat surface any more than you have to picture real pathways for the planets. No sign-posts mark the pathways, and the level or plane cannot be *seen*, except by the way in which the worlds journey.

How far the Solar System reaches, and where it stops, I cannot tell you.

The Sun's power goes out beyond his own

kingdom: for the distant Stars feel his pull. Only that gentle pull is very much weaker than the strong hold which he has over all his own worlds.

Neptune is the most distant world known to us; and Neptune, as you have heard, is some 2,800 millions of miles away from the Sun.

He is all that way off on one side of the Sun and when he gets round to the other side he is just as far off in the other direction. So the breadth of Neptune's whole pathway, from side to side, is not much less than *six thousand millions of miles.*

All the other worlds or planets are within that enormous circle, nearer to the Sun.

But there are comets belonging to the Sun which journey farther off than Neptune and yet come back from time to time, being held captive by the Sun.

Whether our Solar System as a whole is six or ten or twenty thousands of millions of miles across, matters very little. In any case, it is enormous. And yet, though so enormous, the whole Solar System is but one little spot in the great Universe of Stars which God has created.

The one Star in our System is the Sun himself. All other Stars are far away, outside his kingdom and away from it.

Once upon a time, indeed, the worlds may all

have been stars; and the larger planets seem to be still only half-way out of their starry state. Still they are all either cooled or partly-cooled worlds; not stars.

A Star is a Sun: and a Sun is a Star. A world, whether cold or hot, if it does not shine by its own light cannot be called a star. We see abundance of stars in the sky, but they are so distant that our Sun, compared with them, is very near us indeed.

A wide, wide gulf of cold and darkness, of emptiness and desolation, spreads far on every side around our Sun's kingdom.

That is to say, a wide gulf of what would be cold to our earthly bodies, of what would be darkness to our human eyes, of what looks like emptiness and desolation to our little knowledge. But after all, we cannot see much, we do not really know much!

The distance of our Sun has been found out, and the distances of a few Stars have been roughly measured. But what may lie between us and them, who can tell?

We are here on our little Earth, down at the bottom of a deep Ocean of Air, tied and bound and unable to get away. What man has seen and learned from the bottom of his air-ocean is indeed very wonderful; but more wonderful by far are the things which he does not know.

In earlier chapters we have talked about the worlds in smaller sizes, letting one inch stand always for 2,000 miles.

Now, keeping to exactly that same plan, let us try to picture the Solar System on a little scale, with not only sizes but distances thus brought down.

The actual distances you know by this time, perhaps, pretty well. You know that Mercury is about 35 millions of miles from the Sun, the Earth about 92 millions, and so on. But it is not easy to see what these figures really mean, millions and billions sound so much alike.

So now we will fancy the whole big System shrinking and getting smaller till in every part of it each 2,000 miles has become one tiny inch. Our small moon, being 2,000 miles through, is thus a minute ball one inch through.

Bring before your mind the thought of a large shining balloon, for the Sun, about 35 feet through. This would be in the centre.

Mercury, a crab-apple one inch and a half through, will float round the Sun at a distance of *one quarter of a mile.*

Venus, a very large apple, nearly four inches through, will float round it at a distance from the Sun of about *half a mile.*

Earth, another very big apple, rather bigger than Venus, has her pathway all round at a dis-

tance of *three quarters of a mile.* Ten feet off from the Earth floats her tiny Moon.

Mars, another very small apple, two inches through, is more than *one mile* off from the Sun, with two tiny moons.

Jupiter, a large globe three feet and a half through, travels with his five moons at a distance of about *three miles and three quarters*—the Planetoids lying between him and Mars.

Saturn, a globe three feet through, goes round with his moons and rings at a distance of about *seven miles.*

Uranus, a ball less than one foot and a half through, floats with his four moons in a pathway over *fourteen miles* off from the Sun.

Neptune, the outer planet, a rather bigger ball than Uranus, with one moon, travels at a distance of over *twenty-one miles.*

So, on this little scale, the whole pathway of Neptune would be somewhere about forty-two miles across.

All the other worlds would have their journeys inside that circle. Only comets would go farther off than Neptune's pathway.

Where now must we put the very nearest star known to us in all the sky?

On this scale we must put it about TWO HUNDRED THOUSAND MILES AWAY!

And every single inch in those two hundred

thousand miles would stand for 2,000 miles of *real* star-distance.

Now do you begin to see what an enormous gap divides us from the stars?

If we could bring down the whole of the great Solar System to so small a size that it could lie between New York and West Point *then* the very nearest star known to us would be nearly as far away as the Moon is from the Earth. The nearest star would be 200,000 miles off. Our Moon now is 240,000 miles off.

And this great gap is around the Sun's kingdom on all sides, stretching away in every direction. We have not found one single star *nearer* than that, though countless multitudes of stars are very, very much farther away.

Can you picture to yourself a little Solar System lying between New York and West Point—the whole of it there, unless perhaps a few comets might stray a short way beyond; all the worlds, all the moons, all the meteors, nearly all the comets, doing their yearly journeys round and round in this space of forty-two miles?

And then, around that small kingdom of worlds, a great blank empty space, north and south, east and west, above and below, in every direction, nearly as far as the Moon in our sky before a single star could be reached!

How very, very distant they are you begin now to see; do you not?

At first the Moon seemed a long way off, compared with any country in our world; till we began to think of the Sun. And then, compared with the Sun, the Moon seemed near.

And the Sun seemed a very long way off, compared with the Moon; till we began to think of Neptune. And then, compared with Neptune, the Sun seemed near.

And Neptune seemed a very, very long way off, compared with the Sun; till we began to think of the nearest Star. And then, compared with that Star, Neptune seemed near.

And even the very closest of the Stars, which, compared with Neptune, seems so desperately far away, would, as compared with yet more distant Stars, seem almost near!

QUESTIONS.

1. How far does the Solar System reach?

Nobody can say; but at all events beyond Neptune's pathway.

2. Has the Sun any power beyond his own kingdom?

He has power to attract other stars.

3. Does he pull other stars as strongly as he pulls his worlds?

No: much more gently, because of their great distance.

4. How many stars are in our Solar System?

Only one star, the Sun.

5. What lies round our System, between us and all the stars?

A wide empty space of cold and darkness.

6. Do we really know that it is empty?

We can only say that it seems empty to us. We *know* very little about the matter.

7. If we let one inch stand for 2,000 miles, how large will the whole Solar System be?

Less than 50 miles across. It would lie between New York and West Point.

8. Does this mean the whole of it?

The whole of which we know. Some comets may wander a little farther.

9. On that small scale, how near would Mercury be to the Sun?

About a quarter of a mile off.

10. And Venus?

About half a mile off.

11. And the Earth?

About three quarters of a mile off.

12. And Mars?

Over one mile off.

13. And Jupiter?

About three miles and three quarters off.

14 And Saturn?

About seven miles off.

15. And Uranus?

Over fourteen miles off.

16. And Neptune?

More than twenty-one miles off.

17. And the nearest Star?

About two hundred thousand miles off.

CHAPTER XX.

A STARRY UNIVERSE.

I WONDER how many of the Stars you know by sight, so as to be able to point them out one by one, and say, "That is Sirius," or "That is Arcturus," or "That is Capella," or "That is the Pole-star."

We are not now thinking of Planets, but of Stars; not of Worlds, but of Suns; not of our little Solar System, but of the great *Stellar System*, or Universe of Stars.

Our Sun and all his worlds belong to that Starry Universe. And no doubt countless other worlds, as well as countless other suns, belong to it also.

In long-past days the name of "fixed stars" was given to the greater number of shining points in the sky. They are called "fixed" to make a difference between them and the planets, which are seen to be *not* fixed.

Of course all the stars, like all the planets, seem to travel each night across the sky. We have explained this already, and you know quite well now that their nightly journey from east to

west is only a seeming journey—only caused by our Earth's spinning from west to east.

But even thus the stars are "fixed" as they go; for all move in the same direction and at the same speed. One star does not travel here and another there, in opposite ways. All travel the same way. Each group of stars keeps always its own shape. Each star has its own particular place among other stars. It is as if the whole sky moved round in one piece.

The planets behave quite differently. A planet is seen to change its place from day to day, from month to month, *among* the stars. Now it is in this group, and now it is in that group. Now it goes forward, and now it seems to travel backward; or again it appears to stop, and then starts off anew.

These movements of the planets are a mixture of real movements and of seeming movements. They are partly brought about by our Earth's own journeying.

With the stars no such changes are seen. They remain always the same, always fixed in the same groups. These groups are commonly called "*Constellations*."

The Little Bear's tail-tip never wanders away from the Little Bear's body. The four chief body-stars of the Great Bear never part company. Orion's sword never breaks up, and his

belt is always made of three stars in a row, and his feet keep ever at the same distance from his head. Therefore the stars are called "fixed."

And yet they are not fixed.

So far as we can tell, every single Star in the sky, like every Planet, has its own movement. Stars as well as worlds are on the rush. Although we cannot actually *see* all to be moving, we may safely say that all do move.

It seems to us, indeed, as impossible for the stars to be at rest as it is for the planets to be at rest.

You remember why the planets have to be always hastening along their pathways round the Sun. If one of the worlds came to a stop it would at once begin to fall towards the Sun, drawn by the Sun's great pull; and perhaps it might end by dropping into the crimson fiery sea.

And it is much the same with the stars.

Just as the Sun and planets all pull or attract one another, so the stars all pull or attract one another. Each star draws all his neighbor-stars and is drawn by them.

If there were nothing to meet this perpetual *pull* of every star for every other star, then all the stars in the universe would surely in time rush together and become one enormous heap of Suns.

But there is something to meet and overcome this pull. The stars, too, are in motion. Each radiant Sun, by his own swift rush through the sky, so overcomes the pull of other stars that he can keep apart from them as he journeys.

Some go only a few miles each second, like the planets Jupiter and Saturn. Some go as fast as Mars or the Earth. Some rival the flight of Mercury. Others far surpass any of the worlds in speed. There are stars hastening through the sky at a rate of over one hundred, and over two two hundred, and even over three hundred miles each second.

Yet, despite all these journeyings, the stars remain fixed. Century after century we see them overhead in changeless groups.

How can it be so? If each star is taking its own onward journey along its own separate pathway at a rate of at least tens of thousands of miles every day, surely we ought to *see* them moving. Surely a star ought to get nearer to its neighbor on one side, and farther from its neighbor on the other side. How can it be otherwise if all the stars move, and if no two move at just the same speed?

That is exactly what the stars are doing; Each star gets daily nearer or farther away from each of its neighbor stars.

And yet they seem to us to remain fixed.

The star-groups are still the same in shape as when our forefathers looked upon them.

No: we cannot see such changes commonly. And I will tell you why we cannot. It is because our lives are not long enough.

Think once more about the movement of clouds as seen from the ground. A small cloud, low down, will appear to hurry across the sky at a great pace. But you may look for perhaps half-an-hour at far-away clouds, very high up, and notice no change in them.

This does not mean that the clouds high up do not stir. They may be actually moving quite as fast as the little cloud down below. Only, they are so far distant that the movement seems very slow—too slow to be seen at all, it may be, in one short half-hour.

The stars are enormously more distant than the very highest cloud ever seen. However fast they really move those movements are very small, very tiny, as watched from the Earth; so small and tiny that the lives of many men, one after another, are, all together, too short a time for the seeing of star-journeyings from the Earth. Only a very few can be found out thus, by most careful watching.

Among the hosts of travelling stars is our own Sun.

We have spoken so far of the Sun as if he

were fixed in one place, always at rest in the midst of his worlds.

And so far as he has to do with the planets he is at rest. That is to say, he is always in one place *for them*. He is always about the same distance from Mercury, from the Earth, from Jupiter, and from Neptune. He is always just in the middle of the Solar System.

Yet he is not really at rest. He too travels as the other stars travel. He too is on the move—going somewhere in the skies; where, I cannot tell you.

And as he speeds onward he carries with him all his company of worlds and moons, of comets and meteors. They are no trouble at all to him. He carries them in the strong grasp of his attraction as easily as you in walking might bear along with you a muff or a hand-bag.

If you were asked how many stars can be seen any clear night in the sky, you would very likely say—"Oh, thousands and thousands!" You might even reply, "Millions!"

But nobody ever yet saw a million stars without the help of a telescope. Commonly we see at most only two or three thousand stars; and not often so many at once.

For convenience the stars are arranged in Classes, first, second, third, and so on, like the classes in a school.

These Classes are spoken of as Magnitudes, which means "Sizes." But the stars really are put into Classes according to their *brightnesses*: not according to their sizes.

We know very little as yet about the true sizes of the stars. They all look to us, in even the biggest telescopes, as mere bright points, showing no size at all. Some of the brighter stars may be much smaller than others which seem to us more dim.

The shining of a star in our sky depends upon two things. It depends partly on the size and brightness of the star. It depends partly on the nearness of that star to the Earth.

All we are able to do is to arrange them in classes according to their *brightness* as seen from the Earth.

Those which shine the most are called Stars of the First Magnitude; those which come next in brightness are called Stars of the Second Magnitude; and so on.

In the whole sky all around the Earth there are only about twenty Stars of the First Magnitude. Those twenty stars are mere bright points in the sky; none of them so bright as Venus and Jupiter look to us.

Yet they are all Suns; radiant globes of heat and light more or less like our own great Sun; not like a mere planet.

QUESTIONS.

1. What is meant by the Stellar System?

The Universe of Stars to which our Sun belongs.

2. How are Planets known from Stars?

The Stars remain fixed in groups, while Planets are always changing their places among the Stars.

3. What is meant by "Fixed Stars?"

The Stars are so called because of their fixity in certain groups.

4. Tell me the name commonly given to groups of Stars.

They are called Constellations.

5. Name two or three Constellations mentioned in this chapter.

The Little Bear; the Great Bear; Orion.

6. Are the Stars really fixed?

No; they are believed to be all moving.

7. If the Stars are moving why do we not see it?

Because of their immense distance from us. Our lives are not long enough for us to see most of the Stars change their places in our sky.

8. Is the Sun at rest?

Our Sun journeys like other stars through the sky.

9. Does he ever leave his planets behind?

No; he carries them all with him.

10. How does he do so?

By means of his powerful attraction.

11. What is the meaning of "Magnitude?"

The word "Magnitude" means "Size."

12. What is meant by Star-Magnitudes?

The Stars are divided into different classes, called Magnitudes—such as Stars of the First Magnitude, Stars of the Second Magnitude.

13. Are all Stars of the First Magnitude larger than all other Stars?

No; it is a question of brightness, and not of size.

14. What do we really mean by Stars of the First Magnitude?

We mean those stars in our sky which shine more brightly, as seen from the Earth, than any other stars.

15. Does not brighter shining show greater size?

It may sometimes show greater size, or it may only show greater nearness to the Earth.

16. How many Stars of the First Magnitude are there?

About twenty altogether, round the whole sky.

CHAPTER XXI.

STAR-GROUPS.

THE names of different Star-Groups are very old indeed. On a map or globe of the heavens you may see them pictured, with the figure of an animal or a man from which the name of the Constellation is taken.

These figures were no doubt a help, in very early times, when people wished to learn the different stars; though the star-groups can hardly be said to bear any real likeness to the figures.

As we journey round the Sun, month by month, we see him against different Star-groups in the heavens—against one constellation after another.

Actually, of course, we do *not* see the Sun against the stars, since all stars beyond the Sun are hidden by his brightness. But we see at night those stars which lie in the *opposite* direction, and we know each month, without seeing, which group lies exactly *behind the Sun*.

Suppose you are in a room with a lighted lamp on a table in the middle. And suppose you walk slowly round the table.

As you go you will see the lamp against different parts of the room in turn. First, perhaps, against a window, then against a wall, then against a fireplace, then against a door, then against another wall, then against a sideboard or chiffonier, and so on.

The lamp itself does not stir; but you, by moving onward, change its background and give it a sort of "seeming pathway" round the room. If it were very far away, instead of very close, it might really appear to you to be moving.

This is how we see the Sun seem to travel among the different star-groups. He does not go any nearer to the stars than usual; he only comes *between* them and us. In fact he does not really go or come; but as we move on we make him lie between us and one star-group after another.

Twelve constellations are behind this seeming pathway of the Sun, and they are called "The Signs of the Zodiac." It would be a good plan to learn them by heart some day. Here are the names of the twelve star-groups in English and in Latin:

The Ram - - -	Aries.
The Bull - - -	Taurus.
The Twins - - -	Gemini.
The Crab - - -	Cancer.

The Lion - - -	Leo.
The Virgin - -	Virgo.
The Scales - - -	Libra.
The Scorpion - -	Scorpio.
The Archer - - -	Sagittarius.
The Goat - - -	Capricornus.
The Water-carrier - -	Aquarius.
The Fishes - -	Pisces.

In all these twelve groups we find only five stars of the first magnitude.

Besides those particular star-groups which lie behind the Sun as we journey there are many other constellations in all parts of the sky.

Certain stars in the southern half of the heavens can be seen by people living on the northern half of our Earth. And certain stars in the northern half of the heavens can be seen by people living on the southern half of our Earth.

But the very far north stars, lying over, or very nearly over, our north pole, are never seen at all in the far south of the Earth. And the very south stars, lying over, or very nearly over, our south pole, are never seen at all in the far north of the Earth.

People living, for instance, in South Australia cannot get a glimpse of the Pole-star or the Great Bear; and people living in England or in

New England cannot get a glimpse of the Southern Cross.

Remember that, either way, whether from the north pole or from the south pole of the Earth, a man always looks *up* into the sky. The heavens are always *upward*. The sky above the south pole is no more *downward* than the sky above the north pole. All the "downward" of which we know is towards the centre or middle of our Earth.

Nobody now need sit looking up at the sky and saying,

> "Twinkle, twinkle, little star;
> How I wonder what you are!"

for we know what the stars are.

I do not mean for a moment that we know all about them, or that we have not an immense amount still to learn. But we do certainly know what they are. They are *Suns*.

The twinkling is not a part of the stars themselves. It is brought about by the way in which the little rays of star-light travel through our air. If we could get away from the Earth, right outside the air, we should then see the stars to shine steadily, without any twinkling.

Jupiter and Venus and other planets do not twinkle when we look upon them. You may usually know a planet from a star by its not twinkling.

No planet can ever be seen by us, even through the very biggest of telescopes, at such an enormous distance as that of the nearest star. For the planets shine by borrowed light, as our Moon shines; and you know how dim moonlight is, compared with sunlight. Only a sun, shining with the brilliance of its own great heat, can possibly be seen so very, very far away.

Any number of worlds may be there: cooled worlds, like our Earth; half-cooled worlds, like Jupiter and Saturn — such worlds journeying round distant stars as the planets of the Solar System journey round our Sun. Only if they are there we cannot know it; our eyes cannot make them out.

Suppose you and I could go for a long, long journey through the skies, straight from our Earth away to the star Alpha Centauri. That is the nearest star in all the heavens of which we yet know.

Alpha Centauri is a very bright star, one of the First Magnitude. But you cannot see it in our northern skies. You would have to go much farther south to get a sight of Alpha Centauri.

Suppose that we were to start on this vast journey, taking with us the great Lick telescope of California. And suppose that all the way we never once looked back in this direction until we reached the neighborhood of that bright

star—until we got near enough to see Alpha Centauri as a large radiant Sun.

Then suppose that we turned round and gazed through the big telescope towards this little Earth left so far behind.

What do you think we should see?

No Earth at all! No Moon! No Jupiter, no Venus, no Mars, no planets! No great, warm, glowing Sun! Only one little faint distant star sending forth its feeble glimmer!

All else would have vanished utterly. At the distance of the nearest star, nobody, looking in this direction, with man's eyes and with such telescopes as we have on Earth, could find out anything at all about the Solar System. All the worlds and their moons would be hidden. The very most that anyone could see would be our Sun, as one tiny star.

Just so we on the Earth gaze at the far-off stars; and we see them shining as lonely suns with no worlds travelling round them. Yet they *may* not be lonely. Any one of those stars *may* have its own great kingdom of worlds. Any number of planets *may* be there. Who can tell? We are not able to know, because the gentle shining of borrowed or reflected light cannot possibly reach to such a distance. The most that we have any right to say is that we are not able to *see* any worlds belonging to the stars.

QUESTIONS.

1. What is meant by the Signs of the Zodiac?

The twelve constellations against which in turn the Sun is seen in the course of a year.

2. How is the Sun seen against these constellations?

In consequence of our Earth's yearly journey round the Sun.

3. Do we actually see the stars beyond the Sun?

No; for all stars in the same direction as the Sun are hidden by his brightness.

4. Tell me the names of the twelve constellations.

Aries, Taurus, Gemini, Cancer, Leo, Virgo, Libra, Scorpio, Sagittarius, Capricornus, Aquarius, Pisces.

5. How many very bright stars are in those constellations?

Five stars of the first magnitude.

6. Can all stars in the sky be seen from all parts of the Earth?

No. Some stars to the far north are never seen in the far south; and some stars to the far south are never seen in the far north.

7. Tell me of a constellation never seen from Australia.

The Great Bear.

8. Tell me of a star-group never seen from New England.

The Southern Cross.

9. What are Stars?

Stars are Suns.

10. Why do Stars twinkle?

Only because of the way in which their light travels through our air.

11. Tell me of one way by which we may know planets from stars?

A star generally twinkles; and a planet generally does not twinkle.

12. Do any planets belong to the distant stars?

Any of the stars may have worlds belonging to them, but we cannot see such worlds.

13. Why cannot we see them?

Because the distance is too great.

14. Why should we see a star if we cannot see a planet at that distance?

A star shines by its own light. A planet shines only by reflected light, therefore much more dimly.

15. If we could journey to the nearest known star, how much should we see of the Solar System?

No planets nor moon at all: nothing but the Sun as one dim star.

CHAPTER XXII.

GIANT-SUNS AND CLUSTERS.

ALL stars do not shine alike. They are different in brightness, different in size, different in speed.

There are brilliant suns and dim suns, great suns and little suns, fast suns and slow suns, in the universe of stars, just as there are brilliant worlds and dim worlds, great worlds and little worlds, fast worlds and slow worlds, in our Solar System.

But the brightest star is not always truly the biggest star; just as the brightest planet in our sky is by no means always the largest world.

You know how bright Venus is—a good deal brighter than Jupiter. Yet Venus is far, far smaller than Jupiter. Venus is brighter because she is so much the nearer of the two, not at all because of greater size.

The very brightest star in our whole sky is SIRIUS. Yet you must not suppose that Sirius is larger in himself than any other star. He is brighter partly because he is so much *nearer* than most other stars.

I do not mean to say that Sirius is what one would call a very near star, if such a word

can be used about any single star in the sky. Alpha Centauri, though the nearest of which we know, is not really near; and Sirius is perhaps nearly twice as far off as Alpha. That, however, is not much, compared with the enormous distances of many stars.

Sirius is no doubt a splendid Sun, most likely larger and brighter than our Sun. But our Sun is not so very particularly large as a star among stars. He is only large as a Sun among little worlds. Sirius may very well be bigger than our Sun and yet be by no means one of the biggest stars in the sky.

No one has yet been able to measure the actual size of Sirius, because he always looks to us like one point of light. But we know about how far off he is, and we know that our Sun at that same distance would not be so bright a star as Sirius is. This looks as though Sirius were the larger Sun of the two, only without any very startling difference.

Matters are otherwise when we turn to ARCTURUS.

Sirius is in the southern half of the heavens, and Arcturus is perhaps the very brightest star in all the northern half of the heavens, though a good way behind Sirius in radiance.

Arcturus seems to be a truly wonderful Sun. He is eleven millions of times farther away from

us than our Sun is. Imagine what this means! If you had a rope 92 millions of miles long, reaching from our Earth to the Sun, you would need *eleven millions* of such ropes, joined end to end, to reach from the Earth to Arcturus!

If our Sun were moved to where Arcturus is we should see him only as a very dim star indeed. But Arcturus is one of the most brilliant stars in our sky.

This seems to show that he must be an enormous Sun: a very giant among giants; so huge that our great Sun would perhaps be but as a little ball by his side.

Capella, one of our most beautiful northern stars, is believed to be another giant Sun. Our Sun, at the distance of Capella, would be only just visible without a telescope, while Capella is almost, if not quite, as bright as Arcturus. Since the radiance of Capella is certainly not caused by nearness it is most likely caused by great size.

So, although Sirius may be to us "the monarch of the starry skies," he is monarch only in appearance. He is brightest because he is one of the nearer stars, not because he is really one of the very largest. Arcturus, Capella, and others also, are believed far to surpass him in size.

In this little book I must not even try to tell you many of the wonders of the starry heavens. If you wish to learn more you will by-and-by

read in other books about the many-colored suns which are seen in telescopes, and the pairs of suns which journey through the skies in company.*

You will read also about the curious changeable stars, which get bright and dim by turns; and about the extraordinary New Stars, which sometimes appear and last for a while, and then vanish again.†

I am only going to tell you now a very little about Star-Clusters and Nebulæ.

A Star-Cluster is just what its name says it is—a Cluster of Stars very near together. Near, as seen by us at this distance; not always really near.

A great many star-clusters are known, and some can be seen without a telescope, while others are mere specks even in a fairly good telescope.

In some clusters only about one or two hundred stars are seen. In others we find a countless multitude of stars—thousands of suns seemingly packed together in a mass.

The *packed* look comes from great distance. If we were near enough we should see the suns of such a cluster to be well apart—perhaps even very widely separated. You know how the trees

* See "Sun, Moon and Stars," pp. 283–286.

† Ibid, pp. 279–282.

The Nebula in Andromeda.

of a forest, which close at hand stand apart, seem in the distance to shrink close together. That is how the stars do.

One very important cluster you may easily see any clear winter evening—the cluster of the Pleiades. Most people can make out five or six dim stars; and through a mere opera-glass a hundred may be counted.

The word "nebula" means "a cloud." *Nebulæ* is the plural, meaning *clouds*.

But the Nebulæ are not fleeting and watery clouds, like our Earth-clouds. They are pale patches of light in the sky, fixed as the stars themselves—in one spot century after century.

Only two or three of the nebulæ can be seen without a telescope. The brightest of them all is a faint patch in the star-group Andromeda; and the next brightest is "The Great Nebulæ" in the constellation Orion.

Photographs are now taken of the nebula, and we thus see more of their true shapes than could ever be found out by simply gazing at them with our own eyes, which so soon get tired.

It used once to be thought that a Nebula was only a very, very far off star-cluster—too far for the largest telescope ever to make us able to see the little separate star-points.

But it has now been found that many of the

nebulæ are not clusters of stars at all; they are made of shining gases.

Gases out there in the distant sky, it is supposed, do not burn away, like gas here on the Earth, because in the sky, far off, there is no air, and nothing can *burn away* without air. Only when the great masses of gas are very hot they shine with their own heat; and instead of burning away they go on shining, year after year. That is how we see them.

Some nebulæ are made partly of gases and partly of stars. And some star-clusters have a good deal of shining gas round about the stars.

For a long while nobody knew that there was any bright gas round the stars of the Pleiades cluster. But lately, in some photographs taken of the Pleiades, a curious soft haze has come out round several of the stars, as you may see for yourself in a photograph which tells a truer tale than our eyes can tell.

Do you remember hearing that a star is, most likely, a young world not yet cooled? Well, it *may* be that a nebula is a young sun, or cluster of suns, not yet shaped.

These things we cannot know with certainty. We can only say what is believed to be most likely the right explanation.

Perhaps you have sometimes noticed across

The Great Nebula in Orion.

the sky at night a band of pale light, wider here, narrower there.

In a clear evening, after dark, it may always be seen, and it is called THE MILKY WAY.

Stars lie scattered over and around the Milky Way. But beyond and behind all the brighter stars is spread that soft pale band, which in itself is made up of stars — multitudes upon multitudes of distant suns. They are either so very distant or so very small, or perhaps both together, that we cannot see them as separate stars. We only see the general shining of them all.

Through a telescope great numbers of stars can be seen in the Milky Way, yet still the band of hazy light always lies beyond.

The Milky Way belongs to the same vast Universe of Stars to which our Sun belongs. Indeed, our Sun, with all his planets, is actually *in* the Milky Way.

When you are looking up into the sky, trying to learn about the countless suns of the great Universe, never forget one thing—that "our Father in Heaven" has made them all, and is KING over them all.

If we see a lovely picture, or a beautiful building, we naturally want to know more about the man who painted the picture or planned the building.

Then surely, while searching into the grand distances and glory of the skies, we ought to lift our thoughts in reverent adoration to our Father in Heaven, and to the Son of God, by whom "were all things created that are in heaven and that are in earth." For "*without Him was not anything made that was made!*"

QUESTIONS.

1. Are stars all of the same size?

No; some are large and some are small.

2. Are the brightest stars always the largest in size?

Not at all. A star may be brighter than another only because it is much nearer.

3. Which is the brightest star in our heavens?

Sirius, the Dog-star.

4. Is Sirius as bright as Venus?

No; but Venus is a planet, not a star.

5. Is Sirius one of the very largest stars?

Sirius is perhaps bigger than our Sun, but not one of the biggest stars.

6. Why, then, is Sirius the brightest?

Sirius is one of the nearer stars; not actually near, but far nearer than many others.

7. Is our Sun one of the biggest stars?

No; only a moderate-sized star.

8. Tell the names of two giant suns.

Arcturus and Capella.

9. Why do we believe Arcturus and Capella to be larger than Sirius?

Because they are both very bright stars; and yet they are very much farther away than Sirius.

10. What are Star-Clusters?

Clusters of hundreds or thousands of suns, so distant as to seem to us quite close together.

11. What are Nebulæ?

Hazy clouds like patches in the sky.

12. What are Nebulæ made of?

Some are only great masses of shining gas. Sometimes they are made of stars and gases together.

13. Which are the two brightest Nebulæ?

The Nebula in Andromeda and the Nebula in Orion.

14. Tell me the name of a well-known Star-Cluster easily seen?

The Pleiades.

15. What do we learn from a photograph of the Pleiades?

That some of the stars of this cluster have nebula-gas round them.

CHAPTER XXIII.

HOW TO STUDY THE SKY.

Now I want you to get just a tiny idea of how to *begin* to find out for yourself a few Planets and Stars in the sky. In one way, the Planets are the easier of the two to find, in another way they are the more difficult.

They are easier because they are brighter; at least a few of them are. Also, they do not twinkle. That at once distinguishes them from the Stars.

On the other hand they are a little more difficult, because they are always changing their places in the sky. If you learn to know some particular star by sight you will always find that star in the same place among other stars. It may be more to the east or to the west, according to the time of night and of the year; but it will always be in the very same part of the very same star-group. But a planet never keeps long to any particular group of stars.

However, after the Sun and Moon, the easiest heavenly bodies of all to find are, no doubt, Venus and Jupiter.

Venus is at one time of the year a Morning

Planet, and at another time of the year an Evening Planet.

You always see Venus either not very long before sunrise or not very long after sunset. Venus is so near to the Sun that you cannot possibly find her in any part of the sky very far away from the Sun.

So if, in the evening, you see a bright planet away towards the east, you may be sure you are *not* looking at Venus. Since the Sun has lately set in the west Venus will not be anywhere towards the east.

But if you see a very bright untwinkling planet in the west you may be pretty sure that you have found Venus. "Such a lovely star," people often call her. Venus is no star, however.

It is the same with Mercury as with Venus, only *more so;* because Mercury is still closer to the Sun. So Mercury rises a shorter time before the Sun than Venus, or sets a shorter time after the Sun. This makes Mercury not so easy to see as Venus; and Mercury is never so brilliant as Venus, at his best.

Sometimes, when you have found Venus as a shining planet towards the west, you will see another bright and beautiful planet, only a little less radiant, in quite another part of the sky; and then you have most likely found Jupiter.

If you look through a good opera-glass you may perhaps get a glimpse of Jupiter's little moons.

Mars is often not at all difficult to find, because of his red color. He too, like Venus and Jupiter, does not twinkle. He is not, however, nearly so bright as Jupiter.

When you begin to learn the Star-Groups it is wisest to start with those near the north pole.

Ask somebody first to point out to you the Great Bear, with his seven chief stars, all fairly bright: four in the body, and three in the tail. Two of the body-stars are called The Pointers, because they point almost straight at the POLE-STAR.

The end star of the Little Bear's tail is the Pole-Star; and it lies almost exactly over the north pole. As our Earth spins round and round, so that other stars in the sky seem to journey across from east to west, her north pole points always to the Pole-star, and the Pole-star remains always overhead at the north pole.

But the body of the Little Bear seems to travel round and round his own fixed tail-tip. *Seems* to do so: for this is part of the great seeming whirl of the whole sky at night, caused by our Earth's real spinning movement.

In shape the Little Bear is very like the Great Bear, being made of seven stars, four in

the body and three in the tail. Only its stars are a great deal more dim than the seven chief stars of the Great Bear. Two stars of the Little Bear are called "The Guardians of the Pole."

So now you have to fix in your mind the little faint Pole-Star as a starting-point in your study of the heavens.

Round about the Pole-Star are four important constellations which you ought to learn early.

One of the four you know already; and that is the Great Bear—sometimes named "The Plough," and "Charles' Wain." Perhaps the seven stars are in shape at least as much like to a plough, or to a wagon or a dipper, as they are to a bear.

Away to quite the other side of the Pole-Star, and about opposite to the Great Bear, is a constellation named Cassiopeia. Here we find five bright stars shaped somewhat like an easy-chair seen sideways. There are no first-magnitude stars in either the Great Bear or Cassiopeia.

The two other important constellations are on the two other sides of the Pole-Star; making with the Great Bear and Cassiopeia a sort of rough square of four Star-Groups, having the Pole-Star in their centre.

One of the two is the Constellation Lyra;

and in Lyra shines the beautiful first-magnitude star, VEGA.

Opposite to Lyra, on the other side of the Pole-Star, is the Constellation Auriga; and here we come across another first-magnitude star, the giant-sun, CAPELLA.

A certain well-known constellation, Draco, or The Dragon, winds among these stars-groups, passing between the Great Bear and the Little Bear, and so lying very near the Pole-Star.

From the above-named four principal star-groups you may work your way southward in all directions, learning one constellation after another. I can now only point out a very few more.

At no great distance from the Great Bear and from Lyra is a constellation called Boötes; and in this group is found the bright first-magnitude star, ARCTURUS; that giant-sun of which you have heard before.

At no great distance from Auriga — that is, right away in the opposite direction from Boötes—you may note in winter months the gentle shining of the PLEIADES—a star-cluster in the constellation Taurus.

During the winter, as you know, certain star-groups come into view which in summer we cannot see. No doubt you will remember that Taurus is one of those star-groups against

which the Sun is seen, seemingly, to pass in the course of the year. But when you can see the Pleiades you will be sure that the Sun is not *then* between us and Taurus. If he were, Taurus would be above the horizon at the same time as the Sun. And in that case, of course, we could not see Taurus at all, or the Pleiades.

In this same star-group Taurus, is a bright first-magnitude star named ALDEBARAN.

When you have found the Pleiades you are not far from the grandest star-group in the sky, the magnificent constellation of Orion.

In Orion there are two first-magnitude stars, named RIGEL and BETELGEUSE, and many other bright stars also.

The two feet-stars of Orion point in almost a straight line to the very brightest star in the whole sky, SIRIUS; often called "The Dog-Star," because it is in the constellation Canis Major, or The Great Dog.

Arcturus and Capella and Vega are brightest of all stars in the northern half of the sky; for Sirius is in the southern half. But not one of them shines as Sirius shines.

Two very brilliant southern stars, CANOPUS and ALPHA CENTAURI, are never seen from far northern countries. Both of them are brighter than any other first-magnitude star except Sirius. They quite outshine Arcturus.

Alpha Centauri, as you have heard earlier, is the very nearest star to the Earth the distance of which we know.

But Canopus is one of the more distant stars. Since it is so very distant, and so very bright, we believe it to be another giant-sun.

There are many more constellations besides these with which one ought to be acquainted. It is a good plan to look out the different star-groups in a map of the heavens, and then, on a clear night, to find them in the Sky.

QUESTIONS.

1. Which is the easiest heavenly body to find in the Sky, after the Sun and Moon?

The Planet Venus.

2. Where must you look for Venus?

Always rather near the Sun.

3. At what time of day?

Sometimes in the evening, sometimes in the morning.

4. And in what direction?

The same direction as the Sun. If in the morning, Venus will be seen towards the east, before sunrise. If in the evening, towards the west after sunset.

5. Why is Venus the easiest to find?

Because she is brightest of all; brighter than all stars and all other planets.

6. Where is Mercury to be found?

Always near the Sun, like Venus; but Mercury is nearer still, and so is above the horizon a shorter time before or after the Sun.

7. Which is the next brightest world in the sky after Venus?

The planet Jupiter.

8. Where is Jupiter to be found?

In different parts of the sky at different times. He may be known by his brightness, second only to that of Venus.

9. What is Mars like?

Reddish in color; and of course Mars, like other planets, does not twinkle.

10. Which Star remains always in one spot, as seen from Earth?

The Pole-Star, over our North Pole.

11. What constellation does the Pole-star belong to?

The constellation of the Little Bear.

12. Tell me four chief constellations grouped round the Pole-star.

The Great Bear, and Cassiopeia; Lyra and Auriga.

13. Are any first magnitude stars in these four groups?

The bright star Vega, in Lyra; and the bright star Capella, in Auriga.

14. Tell me of another constellation near the Pole-star.

Draco, or the Dragon.

15. Where is the bright star Arcturus?

Arcturus is in the constellation Böotes.

16. Where is the Pleiades cluster?

The Pleiades cluster is in the constellation Taurus.

17. Is there any first-magnitude star in Taurus?

Yes, the bright star Aldebaran.

18. Tell me of a grand star-group near the Pleiades.

The constellation Orion.

19. How many stars of the first magnitude are in Orion?

Two; Rigel and Betelgeuse.

20. Where is the brightest of stars, Sirius?

In the constellation Canis Major, or The Great Dog.

21. How can you find Sirius when you know Orion?

The two feet-stars of Orion point towards Sirius.

22. Tell me of two very brilliant southern stars.

Canopus and Alpha Centauri.